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ABSTRACT

This textbook contains material for the individualized instruction of students training for careers in service stations; automotive, tire, battery, and accessory retail stores; oil jobbers and petroleum product wholesalers, or any wholesale or retail establishment that sells automotive products and services. Included among the topics addressed in the individual units are the following: beginning duties (housekeeping, opening and closing, daily duties, driveway sales, sales transactions, and job health and safety); automotive products technology (fuels, motor oils, filters, batteries, tires, spark plugs, lighting and electrical accessories, mufflers and exhaust system parts, hoses and drive belts, and wiper and washer parts); automotive services (air conditioning, brake systems, cooling systems, chassis, and tire service and repairs); and management and operations (customer relations, stock and inventory control, controlling losses and shortages, promoting a business, employee motivation and incentives, management and administration, and establishing and operating a business). Competency-based in approach, the lessons contain objectives, technical information, and suggested projects. (MN)

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Petroleum Marketing

Selling Automotive
Products and Services

By
Robert R. Luter

Published by
Center for Occupational Curriculum Development
Division of Continuing Education
The University of Texas at Austin

CE 032 959

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Preface

This publication is a revision and replacement of the *Service Station Training Kit* published by this Center in 1966.

Petroleum marketing is one of the career areas in marketing and distributive education. This publication is intended to cover sales and marketing careers for students working in a variety of wholesale and retail operations. Most of the training stations are related to selling and distributing automotive products and services. Not all of these are in the retail service station.

This individualized instruction publication is competency-based. The competencies were compiled and validated by a number of sources and research projects. All of the competencies are covered in *Petroleum Marketing* or in other publications from this Center. Primarily, this instruction is designed to give sales and product technology, and management and administrative competencies.

This publication will help students prepare for training and future careers in (1) service stations, (2) automotive tire, battery, and accessory retail stores, (3) oil jobbers and petroleum products wholesalers, and (4) any wholesale or retail establishment that sells automotive products and services. Closely related to petroleum marketing are the automotive dealerships that sell and service new and used cars, light trucks, and other motor vehicles. These dispense a variety of products and services, including auto parts. All are interrelated. Competencies gained in any one of these is adequate preparation for any of the others.

A final unit is included on entrepreneurship—for those who want to consider establishing and owning their own business. A careful review of this unit should help prepare any student for this important field.

Robert R. Luter
Curriculum Specialist

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Competencies and Content for *Petroleum Marketing*

To be successful on any job, you must have certain knowledge, skills, and attitudes. These are called *competencies.* Whether or not you master a competency will often mean the difference between success and failure on your job and in your training. This publication, plus others that are suggested, will help you develop the particular competencies needed by an employee in the fields of service station operation; automotive tire, battery, and accessory retailing; petroleum products wholesaling and oil jobbing; automobile marketing; and many other related auto products and services types of businesses.

For DECA competition, competencies are broken down into different categories. You may be required to know all of these categories or only a portion of them. Your teacher-coordinator will guide you in achieving and mastering any competency category. Don't be discouraged by the long list. You probably know many of these already and are doing them everyday on the job.

Basic Skills

- Use legible handwriting in preparing forms, messages, and records.
- Listen to directions, assignments, customers, supervisors, or managers.
- Communicate verbally with customers, employees, supervisors, and suppliers.
- Communicate verbally with groups concerning the products and services available.
- Read reports, forms, policies, and product information, and interpret the necessary information to customers and fellow employees.
- Compose and complete correspondence, reports, forms, and notes.
- Perform mathematical computations applicable to marketing functions in petroleum marketing occupations. (*Applied Arithmetic for Distribution*, 2d ed.)
- Use information tables, charts, and graphs, such as tax tables, work schedules, and organization charts. (*Applied Arithmetic for Distribution*, 2d ed.)
- Use the telephone correctly and courteously.
- Use calculating equipment to perform necessary mathematical computations.
- Convert American standard measurements to metric measurements and vice versa. (*Applied Arithmetic for Distribution*, 2d d.)
- Convert computer output such as printouts into usable data.

Social Skills
(Your Attitude Is Showing and YOU: Personal Development for Young Men/Young Women.)

- Demonstrate good work habits, such as punctuality, orderliness, and neatness.
- Demonstrate good work habits by planning and scheduling work tasks and assignments.
- Maintain acceptable appearance and health.
- Adjust and adapt to new and unique ideas and situations.
- Convey a positive image of self and for the place of business.
- Assume responsibility for individual actions and company policies.
- Maintain a positive attitude toward individual responsibilities.
- Accept constructive criticism, and take appropriate corrective actions.

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- Maintain necessary endurance, forbearance, and persistence in order to accomplish goals and objectives.
- Display appropriate sense of humor
- Budget time effectively by managing leisure, work, and home affairs in ways that enable individual goals to be achieved.
- Use success or failure constructively in a work situation.
- Be dependable in the work environment.
- Work cooperatively with other employees, supervisors, and managers.
- Serve customers courteously to represent the firm favorably. *(Practical Selling)*
- Treat others as individuals.
- Work cooperatively with other persons outside the firm such as suppliers, advertisers, and community representatives.
- Use appropriate assertiveness when working with other employees, managers, and customers.
- Be tolerant of the needs, desires, and goals of others.
- Demonstrate initiative in dealing with customers and other employees.
- Apply appropriate leadership styles to help motivate others. (Assignment 33)
- Demonstrate sensitivity to the needs of individuals.
- Assume a shared responsibility for success or failure of the entire group.
- Establish and maintain credibility with customers and co-workers. (Assignment 28)
- Adjust to demands of job requirements such as deadlines, pressures, and conflicts.
- Reinforce positive behavior and provide constructive criticism.

Economic Principles and Concepts

- Demonstrate understanding that profits contribute to the economy of the business and the individual.
- Understand the relationships between profits and sales and expenses.
- Know the influence that competition has on products, prices, and promotion.
- Understand the relationship between supply and demand and the influence on marketing functions. (*Advanced Marketing Curriculum,* Units 2, 3, and 4)
- Understand the characteristics of the free enterprise system and its effects on individual investment opportunities, motivations, and rewards.
- Know the effects of recession and/or inflation on production, sales, and employment.
- Know the role of capital and investment in planning and control for business operations.
- Understand the influence of labor and labor organizations on the economy.
- Know the nature of credit and its influence on the economy. (*Basic Retail Credit*)
- Know the effects of taxation on the economy and individual business.
- Know how laws, regulations, and government agencies affect a business. (Assignments 33 and 34)
- Understand that financial institutions, such as banks, savings and loans, credit unions, and other lending agencies, have an impact on business operations. (Assignment 34)
- Know that prices and market conditions are greatly influenced by our system of marketing and distribution.

Management and Administration

- Determine job classifications, qualifications, and numbers of individuals needed for each job.

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- Write job descriptions and specifications.
- Advertise for jobs in accordance with labor laws and affirmative action.
- Interview prospective employees.
- Select individuals for various positions based on recommendations, qualifications, and experience.
- Obtain necessary information from other sources on each individual applicant.
- Explain benefits to employees, such as social security, health care, pension plans, and various incentives.
- Train employees concerning job responsibilities, duties, policies, procedures, systems, products, and terminology.
- Select appropriate training aids.
- Conduct sales and staff meetings.
- Attend training sessions sponsored by suppliers, trade associations, and manufacturers.
- Plan goals and objectives for specific jobs and promotions.
- Plan job responsibilities and assign authority.
- Establish criteria for employee evaluation.
- Schedule employee working hours.
- Assign work to employees.
- Supervise work of employees.
- Build employee morale and motivation.
- Provide constructive criticism and positive reinforcement, and show appreciation to employees.
- Handle employee complaints in a fair and just manner.
- Determine equipment needs.
- Select new or replacement equipment.
- Plan policies and procedures related to customer service.
- Select site location for business.
- Plan layout to provide appropriate and adequate space for work.
- Determine insurance needs.
- Establish policies and procedures for security.
- Comply with procedure for handling shoplifting, fraud, robbery, and employee theft.
- Establish procedures for adherence to safety measures and accident prevention as specified by OSHA.
- Administer maintenance and housekeeping program.
- Administer overall budget.
- Analyze projected budget and actual budget.
- Perform necessary banking functions such as deposits, checking, and savings.
- Prepare records and reports.
- Interpret financial reports and records, such as financial statements, stock turnover, and gross margin. (*Financial Management*, American Enterprise Series)
- Establish incentive programs.
- Administer wage, salary, and incentive plans.
- Obtain necessary financing.
- Manage legal matters, such as negotiating lease and rent agreements, remodeling, franchises, and other legal matters.
- Manage credit policies and procedures. *(Basic Retail Credit)*
- Promote firm through participation in professional and civic organizations.
- Close out day's business, securing all funds and negotiable assets.
- Establish a delivery system with routes, truck types, and personnel.

Buying and Pricing
(*Advanced Marketing Curriculum*, Units 3 and 4)

- Plan for a balanced and complete inventory.
- Obtain market, merchandising, product, and consumer information.
- Analyze economic forecasts.
- Determine amount of inventory on hand from records.
- Estimate customer demand based on analysis of sales records.
- Determine necessary maximum and minimum quantities of each item of stock.
- Determine and select suppliers for each type of product.
- Use appropriate ordering procedures to place reorders for stock.
- Follow up on completion and delivery of orders.
- Determine amount of fuel on hand, checking pump meters, and measuring tanks.
- Establish pricing policies to ensure adequate gross margin and net profits.
- Establish the markup necessary for each line of products.
- Determine the timing of price reductions and percentage of markdowns.
- Mark and change prices on merchandise.
- Operate ticket or marking machinery, stampers, and other pricing equipment.

Physical Distribution
(*Physical Distribution*, 1979)

- Establish a receiving schedule for gasoline and diesel fuel deliveries.
- Prepare products for storage through a receiving, checking, and marking procedure.
- Check deliveries for completeness of order and condition of incoming merchandise.
- Complete receiving records and invoices.
- Follow correct procedures in handling defective/damaged merchandise.
- Determine best location for stock within the store, station, and pump island.
- Prepare merchandise for selling.
- Store merchandise in appropriate place.
- Analyze reasons for returned merchandise, and take corrective actions.
- Determine maximum on-hand inventory.
- Conduct periodic physical inventories.
- Maintain accurate inventory records.
- Analyze inventory records to detect stock shortages.

Sales Promotion
(*Advanced Marketing Curriculum*, Unit 5; *Promotion Function*, American Enterprise Series)

- Determine target market.
- Determine promotional objectives.
- Plan promotional campaign and strategies.
- Plan promotional schedule such as advertising and/or display schedule.
- Determine when to use promotional and institutional advertising.
- Utilize services of an advertising agency.
- Determine cost of various advertising media.

- Prepare a sales promotion budget.
- Apportion the sales promotion budget to the various activities and strategies.
- Select seasonal merchandise for promotion.
- Determine amount of on-hand stock for promotion purposes.
- Order additional merchandise for promotion.
- Conduct comparison shopping of competitors' products and prices.
- Analyze competitors' promotional activities.
- Determine when and where to use displays.
- Coordinate local advertising with national or chain advertising.
- Develop catalogs and price lists.
- Develop circulars and broadsides. (Assignment 31)
- Determine when to use a personal solicitation campaign.
- Design advertising layout, and write copy.
- Develop advertising messages for radio.
- Develop advertising for television.
- Proof advertising layouts.
- Plan tie-in displays with advertising and other promotional media.
- Develop point-of-sale signs and banners.
- Prepare merchandise for display.
- Maintain displays for appearance and freshness.
- Coordinate displays with advertised features.
- Post current advertising in heavy traffic areas.
- Plan and evaluate effectiveness of displays and advertising.
- Evaluate special promotions.

Selling

(*The Selling Function*, American Enterprise Series; and *Practical Selling*)

- Use canvassing techniques in locating prospective customers.
- Identify customer wants, needs, and problems.
- Inform customers of brand names, grades, available sizes, features, and benefits of products.
- Inform customers of possible substitute merchandise.
- Explain to customers about protective measures regarding standards, grades, and classifications.
- Handle customer complaints in a pleasant and effective manner.
- Suggest additional or related items or a better grade of merchandise.
- Interpret automotive service guides and charts to prescribe needed services.
- Distinguish between detergent and nondetergent oils.
- Explain various motor oil classifications to customers.
- Advise customers about various oil viscosities and what they do.
- Distinguish between various types of lubricants.
- Explain the characteristics of gasolines and diesel fuels.
- Select and recommend various grades of gasolines and diesel fuels.
- Distinguish between the types and uses of various tire materials.
- Explain the various parts of a tire and the uses of tires.
- Explain the various types of tires, construction, plies, and ratings.
- Select the best tire value for the customer's driving needs.

- Explain the various elements of tire sizes, and make appropriate recommendations. (Assignments
- Explain the D.O.T. markings and what they mean
- Analyze the various components of a battery, such as plate numbers, and what they mean in overall performance and quality.
- Explain the care requirements of batteries.
- Explain the feature-benefits of batteries.
- Utilize all safety and precautionary procedures in installing, removing, and charging batteries.
- Recommend batteries on the basis of customer's need and driving conditions.
- Distinguish between the various types of oil, air, and fuel filters.
- Explain the feature-benefits of air filter elements.
- Explain the feature-benefits of various oil filtering elements.
- Explain the advantages of periodic replacement of fuel filters.
- Explain the advantages of periodic inspection, cleaning, and replacement of various PCV system filters and parts.
- Explain uses of and need to change various types of antifreeze compounds.
- Analyze and recommend replacement of worn fan belts and hoses.
- Analyze the causes of lighting failures, and recommend replacement bulbs and other lighting products.
- Analyze the condition of spark plugs, and clean, service, and replace those in poor condition.
- Analyze condition of windshield wiper blades, arms, and washer parts that need service and replacement.
- Analyze conditions that indicate worn or damaged shock absorbers, and recommend correct replacements.
- Analyze and inspect the exhaust system, recommending correct replacement units.
- Greet all customers in accordance with store/station policies.
- Complete sales contracts with customers.
- Operate cash register; itemize sales, ring totals, add appropriate sales taxes, and announce total sale.
- Read catalogs and charts for special items not priced with legible tickets or markings.
- Determine correct price for all merchandise.
- Make change for customers.
- Process checks in accordance with company policies.
- Process credit card sales and invoices in accordance with company policies.
- Make refunds on returned merchandise in accordance with company policies.
- Balance cash drawer receipts against amount of sales made each day.
- Process necessary paperwork and forms on guarantees and warranties of certain merchandise, recording serial numbers and other appropriate data.

1

Housekeeping

Objectives: After completing this assignment, you will be able to—

1. identify areas that need regular cleaning and maintenance;
2. prepare a cleaning and maintenance schedule for your training station; and
3. describe special disposal areas and their maintenance.

Maintaining Appearance

The appearance of the retail sales unit is often the difference between a successful business and one that is not. Customers do not come into a business that is messy, cluttered, and looks disorganized. Cleanliness is a major factor in attracting customers.

Your *beginning duties* most often include maintaining the building and grounds, and particularly the driveway areas and parking spaces. These duties are:

1. Pick up all trash, clutter, loose packing materials, boxes, cans, and papers. Dispose of these in the trash bins provided.
2. Wash down the driveway areas, front walk, and pump islands. Use the detergent, degreasing compounds, brooms, and water hose to clean up oily films, spills, and dirt that catch on the surface.
3. Wash and wipe down the front windows, doors, bay doors to the service areas, and any other glass areas. Use plain water and a squeegee, and dry immediately with a soft cloth.
4. Clean up and straighten the service bay area. Pick up loose tools, and put them in their proper place. Stack and straighten tires, wheels, parts, equipment, and cartons of merchandise. Wipe up oil and grease spills. Wash down and sweep up excess water from floor and bays. Remove any object that might cause someone to trip and fall.
5. Check all external signs to make sure they are standing upright and that sign materials are in place and straight, and in the proper location. Check lighted signs and external lamps, replacing those that are burned out.
6. Clean up the grounds. Remove trash, rake leaves, and water the grass, shrubs, and flowers. Mow when necessary.
7. Paint curbing when needed, using the proper paint. Be neat in your painting. Avoid splatters and spills that look worse than peeling paint.

Housekeeping Tools, Equipment, and Materials

Maintaining the appearance of a place of business requires the right tools and equipment. It is also important to keep cleaning tools and equipment properly stored when not in use. The following tools and equipment are needed.

Floors, Service Bays, and Driveway Areas

- Floor brush, 24-inch or wider
- Dust brush and pan
- Scrub brushes for excessively dirty areas
- Wet mop and mop tank with wringer
- 36-inch floor squeegee for getting up excess moisture after hosing down
- Garden-type water hose with nozzle
- Recommended detergent, oil-soaking materials, floor sweep compound

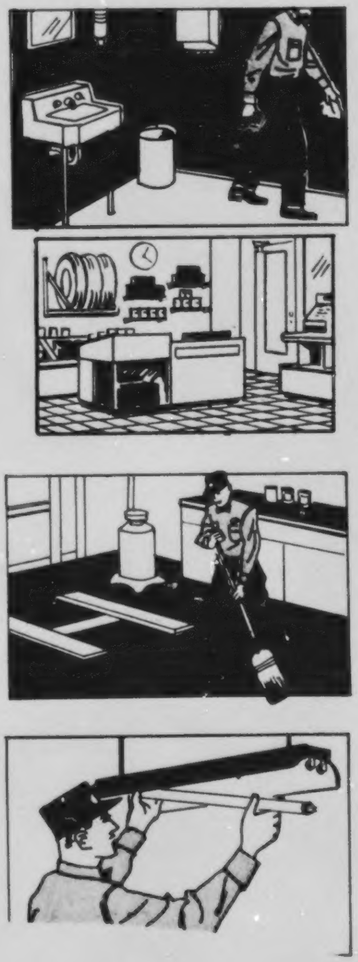


Figure 1-1

Walls and Windows

- 10-inch or larger soft hair brush with extension handle
- Window squeegee with extension handle
- Glass scraper or razor blades for removing paint, adhesive from tapes, insect matter, and other difficult-to-clean spots
- Soft cloths, chamois skins, or soft paper toweling

Grounds

- Yard rake or flex-steel grass rake
- Gravel rake for smoothing landscape rocks in flowerbeds
- Lawn mower
- Grass trimmer
- Snow shovels, ice scrapers (where needed)
- Mechanized snow removal equipment (where needed)

Refuse and Trash Containers

- Oily rag waste disposal and storage equipment
- Trash bins or dumps where trash is picked up on a regular schedule
- Driveway disposal bins for oil cans, paper towels, other waste
- Waste disposal bins in rest rooms

Rest Room Equipment

- Towel racks, storage containers for drying hands
- Bowl brush and container
- Toilet tissue dispensers and seat liners
- Bowl plunger and suction cup

Miscellaneous

- 50-foot (or longer), 1-inch diameter high-pressure water hose and nozzle
- Water pails
- Paintbrushes, paint roller and pan
- 12-foot stepladder, 16-foot (or longer) extension ladder

Cleaning Procedures

Driveway and Pump Island Areas

The driveway and pump island area is where you work and what the customer sees even before turning in. Cleaning and maintenance of this area is a constant job, and has no periodic or regular schedule. All cleaning and picking up is done between customers. In addition to regularly hosing down and sweeping the driveway area, you must constantly clean and maintain the pump island. Never let rags, towels, empty oil cans, or other waste pile up. Dispose of items properly each time in the proper waste disposal can or container. Where a credit card imprinter is kept in the pump island area, make sure that carbon papers and other throw-away trash from credit invoices do not accumulate or blow away in the wind.

Clean and wax gasoline pumps on a regular maintenance schedule. Wash the pump housing with soap and water, dry down, and apply a spray wax made for that purpose. Keep glass dial faces clean and free of oil, grease, and dirt.

Clean and straighten the motor oil racks and display stands. Make sure signs, sign holder racks, and promotional materials are clean, straight, and in place. Check constantly for missing sign material or that which may loosen in the wind.

Keep air hoses and water radiator fill hoses straight, off the driveways, and wound on racks where customers or workers will not trip over them. Make sure they are in place so they will not accidentally catch on a car's bumper.

Check windshield service cabinets to make sure they are filled with wiping materials, solvents, brushes, and other cleaning items. Keep all used towels and rags picked up and in their proper disposal cans. Empty these on a regular basis so they do not overflow and look cluttered.

Rest Rooms

One of the most critical areas for cleanliness, sanitation, and neatness are the rest rooms. Indeed, travelers often choose a service station strictly on the basis of appearance and the likelihood of finding clean rest rooms. No one likes to enter a rest room that is messy, cluttered with paper, or has water standing on the floor. Rest rooms need constant maintenance and cleaning.

Clean the walls, ceiling, partitions, and doors with wall cleaning brushes, and wipe down. Sweep and wet-mop the floors, using recommended cleaners. Be sure not to leave excess moisture that someone may slip on. Wipe down mirrors, and clean the lavoratories and faucets. Clean the toilet bowl, using a bowl brush and disinfectant solution. Clean and straighten towel dispensers and tissue holders. Refill as needed. Leave doors open after cleaning to dry out and air out disinfecting odors.

Station Interior

The station office, sales area, and cashier's stand need periodic cleaning. Clean walls, ceiling, and floors with proper cleaning brushes and equip-

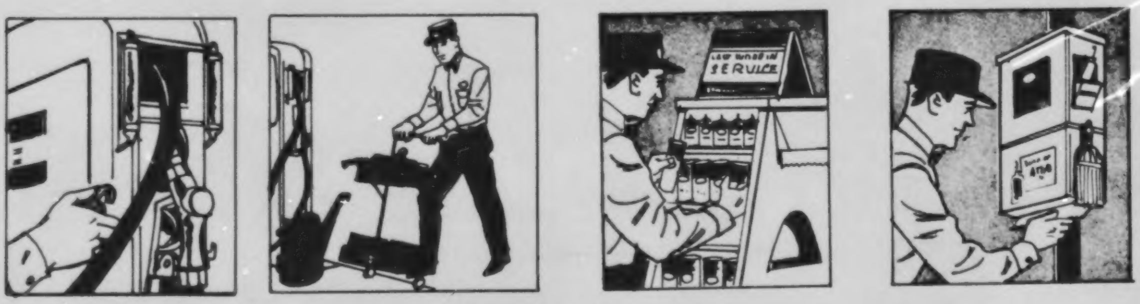


Figure 1-2

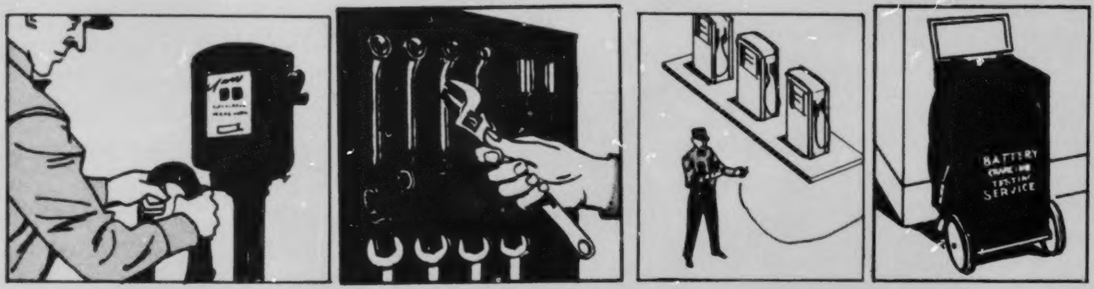


Figure 1-3

ment. Wet-mop and dry the floors. Clean and dust all shelves, merchandise, and equipment at least once a day. Wipe and wash windows at least once a week—more often if needed.

Straighten signs and promotional materials. Pick up and empty trash containers on a regular schedule. Restock shelves from stockroom supplies and merchandise. Rotate stock on shelf so oldest item is in front or on top. Keep sales invoices and service records clean and stored in the proper place. Keep drawers closed tight. Lock and secure anything that requires safekeeping. Keep the front area completely clean and free of clutter.

Yard and Grounds

Many service stations have some grass and lawn areas or landscaping. It gives the business a "homey" look and makes it more attractive and inviting.

Your job is to periodically inspect and maintain this area. Keep the grass mowed and trimmed around walkway and driveway areas. Trim next to curbing, and pick up trash, leaves, and other materials that blow in or pile up. Paper cups, plastic wrap materials, towels, and tissues have a way of collecting on grass areas from the street and driveways.

Keep any shrubs or flowers trimmed. Rake small gravel used for landscaping, and pick up loose waste materials. Paint and clean curbs and gutters. Water the grass and flowerbeds on a periodic basis during the growing season.

Service Bays

Think of the service bay as a sales area as well as a workroom. Many customers enter the service bay area to watch their car being serviced and to talk to the service and sales staff. For safety as well as appearance, the service bay requires constant cleaning and maintenance.

Wipe up all oil and grease spills. Apply drying compound to soak up excess. Pick up all loose papers, trash, packaging materials, tools, and rags. Dispose of oily rags in a special container to prevent fires and explosion. After preparing oil and grease spots, wet-mop the floors, using special compounds. Wash down the floor and bay areas, and squeegee the excess water to the outside. Excess water on the floor is just as dangerous as oil and grease.

Pick up all loose tools, and return them to their proper storage rack. Make sure equipment is in its proper place. Pick up and dispose of used oil in its proper container. Make sure air lines to lubrication guns are suspended properly and not hanging down where they may trip someone.

Clean and wipe down all equipment. Roll or push all equipment back into its proper storage place. Pick up loose tires, tubes, and wheels, and stack properly. Make sure batteries and similar items are not down where they can be easily damaged or tripped over.

Projects

1. Prepare a maintenance and cleaning schedule for your training station. Divide a sheet of paper into three main columns. Label the first column "Constant Cleaning"; the second, "Daily Cleaning"; and the third, "Weekly Cleaning." In the proper column, list the specific areas and items that need constant care and maintenance, daily care (at least once a day), and weekly or periodic maintenance.
2. Describe the special disposal areas that have regular pickup service. These include regular trash and garbage pickup service and what items can be placed here. Another is the oily rag disposal system and who is responsible for pickup and maintenance. Another is the used motor oil sump and who is responsible for disposal. Describe any other waste disposal sites and who is responsible for disposing of each.
3. If your training station sells, mounts, and services tires, batteries, and other automotive parts and accessories, tell how used products are disposed of and who is responsible for maintaining these dump sites. How often are these areas cleaned up and waste products hauled off?

2

Opening and Closing

Objectives: After completing this assignment, you will be able to—

1. identify the step-by-step procedures for opening a business and
2. identify the exact procedures for closing a business.

Getting Ready for Business

Every successful business has one rule: *Open the business on time each day!* This means someone must be there from an hour to 30 minutes ahead of opening time to get everything ready. The size of the station or business determines how long that will take.

Personal Readiness

Employees themselves must be ready for business. That means personal cleanliness and mental alertness. Personal grooming and dress standards differ from place to place. The minimum requirements are these:

1. Daily bath or shower
2. Fresh, clean underwear and socks daily
3. Hair cut or styled appropriately
4. Clean, pressed uniform, or appropriate dress required by the business
5. Clean shoes, free of oil and grease, appropriate for the type of business

To be mentally alert and fresh, you have to take the responsibility to eat the right foods and get enough sleep. You cannot be ready for business if you are tired, sleepy, weak from poor diet and nutrition, or physically run down.

Equipment Readiness

Most places of business have a standard procedure for opening. It may be in the form of a checklist, or it may be some printed instructions. If you do not have these, then you must know exactly what routine to follow and what to do. It is always good to have a daily checklist so that you don't forget very important things. Turning on and checking out the equipment is essential.

First, the *pumps* must be readied for operation. Follow this procedure if you have no checklist:

- Unlock pump and check the readings on the dials. If the readings were not written from the previous day's operation, then record the units and amounts on the forms for this purpose.
- Unlock tire displays, and wheel into position.
- Unlock motor oil display racks, and put into position.
- Turn on water supply to radiator fill hoses.
- Check windshield service cabinets, and refill needed supplies.
- In the service area, turn on air compressor. Connect air hoses, and drain water valve.

Second, gauge and measure each *gasoline storage tank*. Record readings on appropriate form. Make sure caps are replaced securely. Replace gauge sticks in proper storage place.

Third, open *service bay* doors, and check to be sure all tools are in place. Turn on operating equipment. Plug in battery charger unit.

Display Readiness

Set out all displays of merchandise that are usually in the open. These include tires, batteries, motor oils, and other necessary items. Set out all signs, making sure they are in good condition. Check all banners and pennants that may be used. See that they are secured at both ends and are hanging properly.

Rest Room Readiness

Open the rest rooms. Make sure they are clean and ready for use. Check supplies, and refill as needed. Many stations keep rest rooms locked between customers. If this is the rule, then check the rest rooms, inspect for cleanliness, lock, and return keys to proper storage place.

Financial Readiness

Prepare the sales room for business. This procedure varies from one business to another. Follow the procedure your station uses.

Open the register drawer. Unlock storage place for change fund. Count change into drawer, beginning with pennies, then nickels, dimes, quarters, and bills. Make sure change fund count is exact. If it is the procedure, then take a reading of the register from the previous day's business, and record or check against the previous record. This is a good double-check system to spot possible errors in reading or writing down numbers.

Close the register drawer. Keep it closed between all transactions.

Prepare credit invoices. Remove them from locked security, and place next to the credit card imprinter. Record the top invoice number. Invoices are numbered in sequence and must be kept in order so that there is control over possible misuse.

Check to make sure all records and forms are in place and ready to use. These include service work orders, sales invoices, warranties and guarantees on tires and batteries, and stock and inventory records or forms.

Final Preparation

After getting the sales room ready, check to make sure all interior lights are on. Check that everything is clean and ready for business.

On the exterior, turn on lighted signs. Turn on driveway lights and pump island lights.

Check vending machines. If the station resupplies these, then open each machine and fill. Empty coin storage daily, and record amounts on the proper form. If a vending supplier checks these, then make sure vending area is clean and lighted, ready for business.

As a final check, it is always a good habit to take one last look around the entire property to make sure everything is ready and in order.

Procedure for Closing

It is just as important to have a routine for closing as it is for opening. In fact, it is even more important to use a checklist to close to make sure everything is in order.

Closing procedures can begin at least 30 minutes before final lockup. Late evening business consists mainly of gasoline customers, so the sales room and service bays can begin closing operations earlier.

Begin on the outside, and work toward the business office. Take in all displays, lock and secure them, or push into proper overnight storage place.

In service bays, secure all tools, and turn off all equipment. Unplug any electrical appliances.

Make sure no equipment or tools are left outside. It is important to check the back of the station, the grounds, and on all sides. Look for ladders, packing crates, or boxes left outside. These can be used by burglars to climb in windows or onto the roof to get inside. Make sure windows are closed tightly and locked from the inside.

Begin closing the pumps. Turn off each pump. Take readings and record.

Take in all loose supplies such as towels, can openers, motor oil racks, and cleaning supplies. Turn off water to radiator fill hoses. Turn off the air compressor, and disconnect outside hoses.

Final Closing Procedures

Gauge and record all gasoline tanks. Check the stockroom and storeroom. Lock and secure all windows and doors.

Begin closing the register and financial records. Count out the daily change fund, record, put in bag, and secure in its place. Count the remaining change in the register drawer. Make the deposit slip. Secure all money and valuables in the night depository.

Record the last credit invoice number beside the closing entry. Secure the remaining invoices in proper storage space, and lock up.

Begin room-by-room inspection. Check for open windows, unlocked windows, equipment left running. Turn off air-conditioning and heating equipment. Turn out lights. Lock doors, and make sure they are securely locked.

Turn out exterior lights except those left on for security and safety.

Double-check

It is a good habit to make one final inspection round. Look for little things that may have been left open or not put away. Listen for electrical appliances or equipment left on—especially heating and air-conditioning units. Listen for running water in the pipes. This may indicate a stuck valve in a rest room lavatory or commode or an outside water hose left running.

It is important to check room by room before final closing. You can't afford to lock up a customer in a rest room or service bay. More important, you don't want to lock up a would-be burglar who purposely hides until after you close. Open each storeroom, stockroom, sales room, and service bay door, and look around before turning out the lights.

Finally, lock and secure the front door. If you are responsible for taking the night receipts to deposit in the bank, you want to be especially cautious. Look for persons who may be loitering nearby. Look for cars parked close by that aren't usually parked there. Never openly display a bank pouch or deposit bag. Tuck it inside your shirt or coat. Never use the same route to the bank. Vary it from night to night so you are less likely to be followed. If you think you are being followed, drive straight to the police station. Ask the police to accompany you to the bank depository.

Finally, after making the night deposit, drive back by the station and take a final look for anything left undone.

Projects

1. Prepare a checklist of the procedures normally followed in opening for business at your training station. Divide the checklist into areas, such as the pump island, exterior, service bays, sales room and stockroom, and business office. Make a step-by-step listing of specific things to be done each day. If you do not know this procedure, ask your training sponsor to help you.

2. Prepare a checklist of the procedures normally followed in closing the business at your training station. Divide the checklist into areas, as in the opening procedures, and make a step-by-step list of specific things to be done. Ask your training sponsor for help if you are not sure of the procedures.

3

Daily Duties

Objectives: After completing this assignment, you will be able to—

1. identify the equipment that requires periodic and routine maintenance;
2. describe how to order and receive a shipment of gasoline; and
3. make a maintenance schedule that fits the specific needs of your training station.

Normally, you have regular assigned duties to perform every day. In general, these can be divided into housekeeping, equipment maintenance, sales, service, and operations. Housekeeping chores have been covered, along with opening and closing procedures.

Operations

Gasoline pumps and storage tanks require at least daily checking and recording. In some places with high business activity, readings may be taken more than once a day.

Pump readings are normally taken at the close and/or opening of each business day. Pumps are numbered, and each pump has a ledger sheet. Where a station stays open 24 hours daily, readings should be taken at the beginning or end of each shift. It is advisable to have another person double-check your figures. On small dials, it is easy to confuse certain numerals that look alike. It is also common to transpose digits when reading and recording large numbers.

Gauge and record storage tanks at least once daily. Most stations take the tank readings at the same time as the pump readings. Insert the stick into the tank until it touches the bottom, and withdraw it quickly. If you leave the stick in the tank for as much as a few seconds, the level will creep upward by as much as an inch, giving an inaccurate reading.

When inserting the stick, avoid splashing or disturbing the surface tension as this too will cause an inaccurate reading. Read the level to the nearest ¼ inch, and determine the gallons from the conversion chart. It is also good policy to make a gallonage comparison between the tank gauge and the pump meters. This will help avoid inaccurate readings.

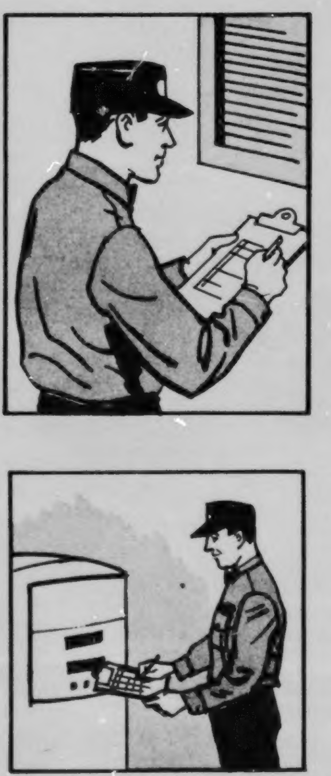


Fig. 3-1. Check tank deliveries against pump readings.

Storage tanks for gasoline produce moisture. It is unavoidable because of rapid evaporation and condensation, plus changes in temperature. So that you won't read the water level, and to prevent excess amounts from fouling the pumps, use this procedure.

Test the tanks daily, using a special water-finding paste on the gauge stick. Two inches of water or less does no harm. More than 2 inches indicates an excess and must be pumped out. Remove the pump housing, and drain water that collects in the air separation chamber. Remove the drain plug, and let the water run from the chamber. When gasoline begins to run, replug the drain. Always replace fill caps securely.

Check each pump daily for accurate readings. Most stations have a 5-gallon "prover can." It is a special can designed for accurate measure. Run an exact 5 gallons of gasoline from the pump into the can. Then check the level in the can filler neck for exact amount. If the reading in the can is over or under the allowable, then the pump should be adjusted to deliver the correct amount.

Receiving Gasoline Deliveries

Gasoline deliveries depend on the amount of business and sales volume. They are not on a regular schedule in most situations. Each company has its own ordering procedures to the bulk plant or wholesale jobber. In most cases, you can follow this procedure.

- Gauge the storage tanks before the truck tanker begins unloading.
- Climb up on top of the tank truck, and check each compartment to make sure it is up to the full mark.
- Gauge each tank immediately after unloading.
- Double-check to make sure tank readings correspond with delivery amounts.

Routine Equipment Maintenance

Regular planned maintenance of equipment does several things: (1) It keeps the equipment operating correctly. (2) It makes the equipment last longer. (3) It makes the equipment safer to operate and be around. (4) It prevents untimely breakdowns. For example, a broken, inoperable air compressor puts a number of service functions out of business. An inoperable gasoline pump prevents sales from that tank.

A planned maintenance program has a checklist of things to do on a schedule for each piece of equipment. It includes lubrication; checking belts for tension and signs of wear; checking for damaged parts, frayed electrical wiring, and leaking or worn hoses and connections; and cleaning.

Gasoline Pumps

Check gasoline pumps daily. Preferably, check them when taking the pump readings. Check hoses, connections, and packing glands. Check the cutoff switch and electrical connections. Oil the motor bearings, and keep the oil well level up to the full mark. Check drive belts for tension and signs of wear. Check housing panels to see that they lock securely and that the pump housing is firmly anchored to the pump island.

Hydraulic Lifts

Hydraulic lifts need regular maintenance and inspection for maximum safety and operation. Maintain oil at the proper level. Check for hold and jerky or uneven operation. Check for signs of oil leakage. Check for air leaks. Lubricate parts. Keep tools and objects away from the main valves and piston so they are not damaged.

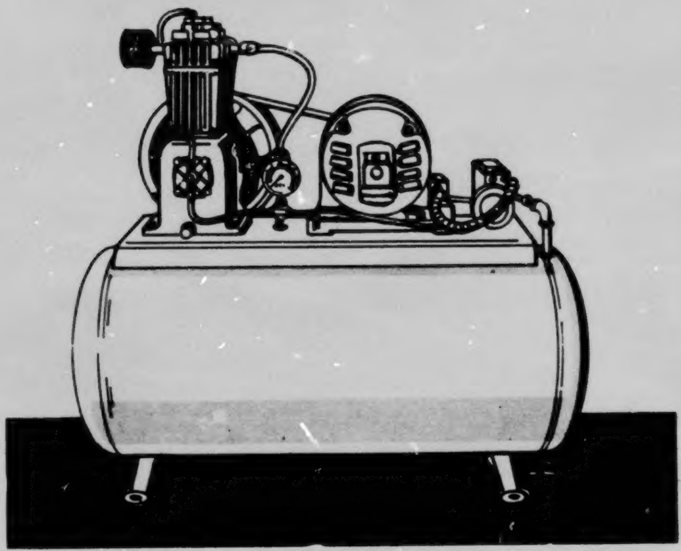


Fig. 3-2. The air compressor requires constant inspection and maintenance.

Lubrication Equipment

Lubrication equipment needs daily inspection and routine maintenance. Look for grease leaks, damaged or worn gaskets and seals, and leaky swivel joints and connectors. Check guns for air leaks. Keep hoses free of oil and grease buildup that causes cracks and deterioration.

Hydraulic Bumper Jacks

Hydraulic bumper jacks should be wiped down daily, and the fluid level checked weekly. Use only the specified hydraulic fluid. Oil all moving parts with heavy grade motor oil every 60 days.

Air Compressor

The air compressor is an essential piece of equipment that requires constant maintenance and inspection. Keep all trash, boxes, cartons, or tools away from the compressor. It needs air circulation all around, and loose materials can get caught in the pulley wheels and belts.

Drain water from the tank at least once a week, and more often when humidity is high. Check for air leaks, particularly on the tank seams. Check the drive belt for proper tension and signs of cracks, fraying, or wear. Replace worn belts immediately.

Clean and oil the air intake filter at least once a month, and more often during dry or dusty conditions. Check the crankcase oil level each week. Drain and refill each month.

Lubricate motor bearings each month. Look for signs of arcing current inside the motor housing. Check the gauges. Excessive pressure in the air tank means the cutoff switch is not working properly. If you let the problem go too long, you may damage the pump and run the risk of tank rupture and explosion.

If the compressor runs constantly with little shutoff time, it means air leaks in the hoses, lines, or connections. Check these for possible replacement or repair. Be sure the compressor is cut off when the business is closed. NEVER BLOCK the relay connections to get higher pressure in the tank. You run the risk of a high-pressure rupture and damage, plus personal injury to anyone close by.

Cooling and Heating Equipment

Air conditioners and heating equipment should have weekly inspections. Clean or replace air filters weekly during high operating times. Keep return air vents clear of trash or stacks of materials that keep air from freely circulating.

Check for signs of gas leaks, leaking joints, or frayed electrical wiring. Check the thermostat to make sure it is on the proper setting. Make sure air conditioner drain lines are open so excessive moisture does not build up and stand in the bottom of the operating unit. Listen for excessive fan noise that may indicate burned motor bearings, or only a loose housing.

Rest Rooms

Rest rooms need daily inspection for leaking faucets or running commodes. These can waste huge amounts of water in one day's time. Replace worn gaskets in faucets. Replace worn tank flush valves and floats. Make sure the float lever arm is not bent so that the tank fills too high or too low for proper operation. Polish chrome parts daily to prevent corrosion. Keep drains open and running freely. Look for signs of water leaks around pipe joints.

Tools

Any tool is designed for a specific purpose and use. It is designed to help you in your service and repair work. Misusing or abusing a tool has several possible results. (1) Misuse may cause injury to yourself or damage to the equipment you are working on. (2) Abuse ruins an expensive tool that may have to be replaced. (3) A damaged tool has little or no value if it cannot do the job it is designed for.

Every tool has a place. Unless the tool is where it belongs, much valuable time is lost by those who need it. Tools left lying on the floor, under the hydraulic lift, inside the service pit, or on the driveway are both dangerous and unseen. They may cause tripping, bad falls, injury, and lost time. Tools left around the pump island or drive areas may cause injury to a customer and a possible lawsuit.

Tools belong to the company. Never lend them to anyone for any reason. That should be a firm and enforced company policy.

Keep tools clean. Oil and grease ruin a good tool, make it difficult to grip or use, and ruin the finish. Dirt and grit stick to oil and grease, causing excessive wear and a ruined finish. Electrical tools must be kept clean and in good repair. Check the wiring and plug for damage, fraying, cracks, and loose screws or connectors. Pneumatic tools must be kept clean and free of dirt, oil, and grease. Check for tight air hoses and connectors, loose screws, or damaged and worn parts. Never use a damaged tool or one that needs repair.

Treat tools with care and respect. Put them up when not in use. Return all tools to their proper storage space or rack.

Projects

1. Make an equipment maintenance schedule for your training station. First, make a list of all the equipment that needs routine maintenance and inspection. Include gasoline pumps, hydraulic lifts, jacks, compressors, cooling and heating equipment, and lubrication equipment. Second, under each equipment heading, mark off three columns, labeled *Daily*, *Weekly*, and *Monthly*. Then under each column, list the specific inspection or maintenance duties to be done. Have your training sponsor check the list when it is completed to make sure everything has been included and that the maintenance schedule is correct.

2. Describe how gasoline is ordered and received at your training station. What is the procedure for checking gasoline units before and after delivery? What records are required? From whom does your station order gasoline deliveries?

Objectives: After completing this assignment, you will be able to—

1. describe the five-step driveway selling plan for a single salesperson;
2. describe the procedure for a two-person sales team; and
3. tell how to sell a service maintenance program to a customer.

4

Driveway Selling

Today's service stations have changed a lot in operation. Many have gone completely self-service to cut down on personnel costs. Some have two different sections or pump islands—one for self-service and one for full-service. And some have remained full-service in character. A full-service station indicates that an attendant greets the customer, fills the gasoline tank, and does routine services around the automobile. In addition, a full-service station nearly always stocks a full line of tires, batteries, and accessories (TBA) and has service bays and a wash rack.

The self-service concept grew out of competition and was originally a merchandising strategy. By cutting out the routine cleaning and checking services, and by letting the customer put the gasoline in the tank, the station could reduce the cost of gasoline by several cents a gallon. It was a form of discounting that caught on.

However, many station dealers and operators have learned that self-service does not really pay in the long run. Volume gasoline sales alone will not provide the profit margin needed. Many stations that were strictly self-service have returned—at least partly—to offering TBA, as well as other needed car services. With the number of cars being driven today, services are more important than ever. Where is a better or more convenient location for these merchandise and service needs than the service station or automotive supply store?

The Need to Sell

An automobile is a costly investment. It requires constant inspection and maintenance. Each time the owner drives in for fuel, the automobile needs a fast check, inspection, and minor services. This is the time to check the crankcase oil level, the radiator fluid level, the drive belts, and the tires. Cleaning the windshield and other windows is a courtesy service, but the other inspections are more important to the owner in maintaining the car.

These services take only a minute or two. The motorist can easily do them, but many people do not take the time. That is why the service station can provide a valuable service and generate profitable sales at the same time. Preventive maintenance is still the best and least expensive kind of maintenance.

Regardless of your job title, you must be a driveway *salesperson*. You can take more pride in your work. You can earn more. You can be more valuable to your employer. You can be of service to the motorist.

The Five-Step Plan

Unless told otherwise by your training station, you can use the following plan to quickly and effectively sell essential products and services.

Step 1: Greet the customer. With a sincere smile and welcome, greet the driver with a cheerful, "Good morning (afternoon/evening). May I fill it up?" Automobiles today may take diesel fuel, unleaded gasoline, or regular gasoline. So, always check to be sure before delivering fuel into the tank. Never deliver gasoline into a car that takes diesel fuel. It is illegal to deliver leaded gasoline into a tank marked "unleaded fuel only," even if the driver says "regular."

Step 2: Begin gasoline or diesel fuel delivery with automatic nozzle. Remove gasoline tank cap, and insert nozzle. Set fuel delivery on slow with automatic lever. Walk around the car, and observe tires for low pressure, missing tread, large sidewall cracks, or bulges. Wash windshield on driver's side, and wipe dry. Walk to front of car, and raise the hood. Walk to passenger side, and complete windshield wash and dry.

Step 3: Begin under-the-hood inspection. Check radiator for signs of steam or leaks. Check radiator reserve reservoir or tank. On newer models, most radiator tanks have caps that should not be removed except for excessively low fluid or cooling problems. If reservoir tank is low, fill with proper water/antifreeze mixture.

Check crankcase oil dipstick. If oil is below "operating range" level, show the dipstick to the driver. Ask if the car has been traveling at highway speed. Suggest adding one quart to bring up to full mark. If oil looks excessively dirty, ask how long since the last oil change. Check end door panel on driver's side for brand and weight of oil currently in the engine.

Check drive belts for signs of fraying, cracking, or loose tension.

For batteries with fill caps on top, check battery fluid level. Fill as needed to top of ring only. Do not overfill. Check for heavy corrosion on cable connectors and battery posts. Clean with rag, and apply corrosion spray or heavy grease to connector metal parts only.

Check windshield washer reservoir, and refill if needed. Check windshield wiper blades for signs of streaking, smearing, cracking, and warping. Ask the owner to let you replace worn, damaged blades. Close the hood, and make sure it is latched securely.

Step 4: Move to passenger side, cleaning side glasses and rear window. Observe tires on right side of car, looking for bulges, cuts, sidewall cracks, low pressure, or other signs of tire trouble. If you spot a low tire, air it to proper pressure. Look for signs of puncture, nails, glass, rocks, or cracks. Check air valve for leaking. Advise owner of any tire that needs replacement. Tell him or her about tires you carry in stock, and ask for the order.

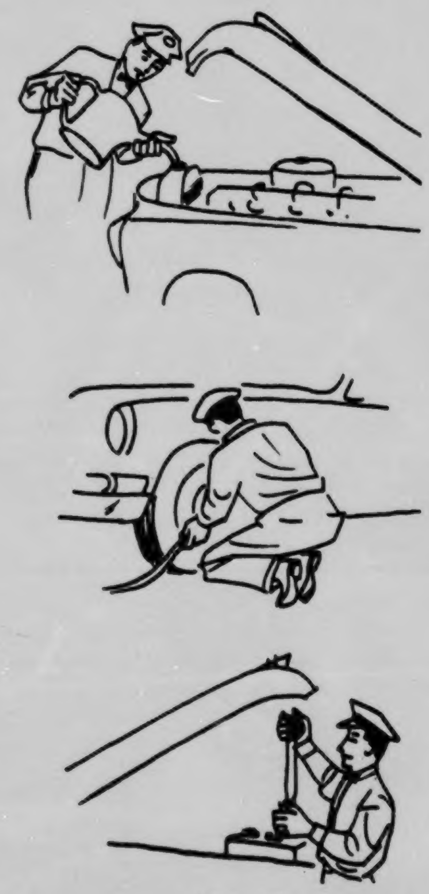


Figure 4-1

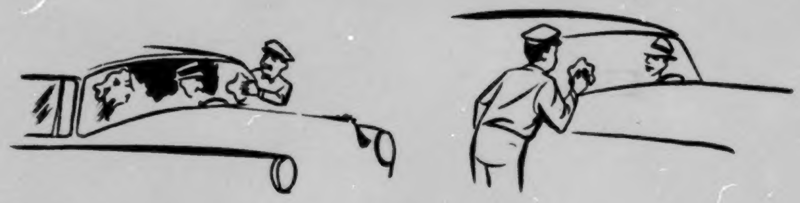


Figure 4-2

Step 5: Complete fuel delivery; total purchases; complete sale of all items. Advise owner of other services. Remind him or her about oil and filter changes, lubrication services, and other routine maintenance services that your station provides. Thank the owner after completion of sale, and ask him or her to return.

Two-Person Sales/ Service Team

Many high-volume stations use two people to service each automobile. It is faster and more efficient and assures better service for each motorist. The two-person team has a leader and an assistant. The leader greets the customer and makes all sales contacts. The assistant provides the routine services and points out sales and service needs to the leader.

The duties of the leader are these:

- Greet the motorist, and take the fuel order. Relay the type of fuel and amount to the assistant.
- Begin under-the-hood service and inspection. Complete inspection and close hood.
- Complete sales of all items. Make suggested service needs to the owner, taking any suggestions from assistant about things he or she has spotted.
- Complete sales transaction, thank the motorist, and invite return visit.

The duties of the assistant are these:

- Take fuel order from leader, and begin fuel delivery. Begin cleaning rear window.
- Observe tire needs, clean side glasses, and move to front.
- Clean windshield and headlamps. Observe needs, and report to leader.
- Complete fuel delivery, and report sale amount and gallonage to leader.

Selling Services

Only a small percentage of motorists who drive in for fuel will ask for additional services. Most are in a hurry and don't want to take the time to have needed services done, or to even ask about them. Your biggest and most important job is to sell services as well as products.

When an automobile receives an oil change and lubrication job, a sticker is nearly always placed on the end door panel on the driver's side. You shouldn't open the door without asking the owner, but there is a simple way to check the sticker. When cleaning the windshield, ask to clean the inside as well on the driver's side. Check the end panel for the date of the last oil change. You can also note the mileage on the odometer.

Mileage of more than 5,000 miles since the last change, or very dirty oil on the dipstick, should prompt you to ask the owner for an *oil and filter change*. Your major selling points are these:

- It will only take a few minutes to make the change.
- Dirty oil is not lubricating properly and is causing excessive wear on engine parts.
- If the owner does not have time today, you can make an appointment for later in the week.
- Suggest a regular maintenance program to keep the car in top

shape all of the time. Regular maintenance catches little things and prevents excessive repair bills later on.

Sell lubrication on a regular basis and service schedule. Sell wash and wax to keep the car looking new and protect the finish.

Sell a *regular maintenance program* that looks after major parts and accessories, such as tires, battery, shock absorbers, fan belts, filters, and exhaust and emission controls. Such a program keeps the car in top running condition, is less expensive than major repair bills, and lets the motorist drive free of worry. A regular maintenance program includes:

- Routine inspection of all under-the-hood areas
- Routine inspection of all chassis parts
- Routine maintenance, inspection, rotation, and balancing of tires
- Regular washing, waxing, and interior cleaning to preserve car finish and upholstery
- Constant servicing of air-conditioning and heating equipment and connecting hoses

Remember, the time to sell services is while the motorist has stopped for refueling. Gentle reminders of how easy it can be, plus the fact that the service station has the tools and equipment that the motorist does not have, can be your two main selling points. More persuasive selling reminds the customer that expensive repair bills, inconvenience, and excessive wear are the results of haphazard maintenance. A little time taken now can prevent major car troubles later on.

Questions

1. Why is driveway selling important in view of the trend toward self-service?
2. Describe briefly the five-step selling plan for a single driveway salesperson.
3. Describe how the two-person sales team operates.
4. What can you do to sell a service program to a customer?

5

Handling the Sales Transaction

Objectives: After completing this assignment, you will be able to—

1. describe the procedure for handling a cash sales transaction;
2. describe the precautions and guidelines for accepting a personal check, traveler's check, and money order; and
3. discuss the procedures in accepting credit cards, including restrictions and authorizations.

One of your basic duties is handling the final sales transaction. In service stations and automotive accessory places, payment may be made in one of several ways. Cash sales may be paid by cash, check, traveler's check, or money order. Credit sales are usually by credit card. In some cases, the owner may personally extend credit to a well-known customer.

Cash Sales

Cash or Currency

Where the customer pays with cash, sales transactions are simple and easy. The amount of the sale is deducted from the bill or bills given, and change is returned. It is proper to say to the customer, for example, "that is $27.22 out of thirty dollars." When registering the sale, make sure the amount registered is accurate. On some types of registers, you also register the amount of money given by the customer. In this case, the amount of change is figured automatically, and you see it on both the register dial and the tape.

When the register drawer opens, deposit the money given by the customer in the change drawer. Then count out the change from the drawer. The correct method is to begin with the amount of the sale, and count up to the amount given, using the least number of coins and bills possible. In the example above, you count the change silently to yourself, like this: "twenty-seven, twenty-two out of thirty dollars." Beginning with the pennies, you then count: "twenty-three, twenty-four, twenty-five." Then move to the quarters, and count: "fifty, seventy-five, twenty-eight dollars." Then move to the dollar bill section, and count: "twenty-nine and thirty dollars."

For a sale of $27.22 out of $30.00, you give back three pennies, three quarters, and two one-dollar bills. You count back the change to the customer in the same order that you took them out of the change drawer. You repeat to the customer the amount of the sale, and the amount of money given, as "that was $27.22 out of thirty dollars." Count out the pennies: "twenty-three, twenty-four, twenty-five." Count out the quarters: "fifty, seventy-five, twenty-eight dollars." Count out the dollars: "twenty-nine and thirty dollars. Thank you very much, and please come in again."

Personal Checks

Most places of business have strict rules about accepting and cashing personal checks. The two basic rules followed are (1) the check must be on a local bank and (2) you must know the customer or he or she must have acceptable identification.

Other good rules to follow are these: Do not accept two-party checks or payroll checks, even if the company is well known. A *two-party check* is one made by one person with another person as the payee. You may know the customer who is the payee, but not know the maker of the check.

Payroll checks are often too large in amount, and too much change would have to be given. You run two risks with *payroll checks*. (1) You deplete your change fund. (2) If the check is stolen, you have lost not only the amount of the sale, but also all the money given in change.

Personal checks, if accepted, should be made out by the customer for the amount of the sale only.

Require positive identification. The best identification has a picture of the person, plus a signature and an address. Most driver's licenses have all this on them. Look at the picture and the person. Compare signatures. Ask if the person is still at the same address or has recently moved. Compare the address on the check with that on the identification piece.

Another good identification is the employee security tag issued by many companies that has the person's picture and name. Credit cards are acceptable if they have been signed and you can compare signatures and if the person has several different credit cards or bank cards.

Compare items on the check for accuracy and correctness:

1. Date line should have today's date. Do not accept a postdated check, or one that is 30 days or older.

2. If payee line is left blank, use a rubber stamp with the company name, or write in the company name.
3. Written amount and numerical amount must agree.
4. Signature must be legible and should be the same as that on the identification.
5. The bank's name and address must be printed on the check. Counter checks or drafts where the name is written in are no longer legally acceptable.

When you have checked for legibility, accuracy, and identification, turn the check over and endorse it immediately. Either use a rubber stamp, or write in the name of the company.

Traveler's Checks and Money Orders

A traveler's check and a money order are the same as cash. However, proper identification is required on both. Because both types of instruments are easily lost or stolen, it is recommended that you either know the person or require good identification.

A *traveler's check* is a definite sum of money guaranteed by a reliable company or bank. The amount of the check is printed in the corners, the same as currency. Most traveler's checks have two signature lines. One is signed by the person at the time of purchase. The second is signed when the person cashes the check. You can then compare both signatures to see that they match. Also required is the current date and the name of the payee. Follow all other procedures in endorsing and processing the check.

A *money order* is made out like a check with a definite amount written in. To prevent the amount from being "raised," or increased, each money order has a maximum value. That is, it cannot exceed the stated amount of $5.00, $10.00, $50.00, or whatever value is printed on it. Again, the money order is guaranteed payment by a reliable company. It should be handled like cash once it is endorsed by the payee.

Most money orders are purchased to pay bills and are made out to a company. However, sometimes a money order is made to an individual. When proper endorsement is made, and the person can present good identification, it is legal to accept a money order as payment. Make sure, however, that your training station will permit you to accept a money order. When in doubt, always ask the manager or owner.

Credit Sales

Credit Cards

The great bulk of sales nowadays for fuel, oil, lubrication, and accessories is by company credit card. In addition, many places also accept bank credit cards, such as Visa or MasterCard. Some also take other credit cards, such as American Express, Carte Blanche, and Diner's Club.

The use of credit has many advantages for millions of consumers. It permits people to travel and charge necessary expenses without worrying about running short of cash. But this same convenience has serious disadvantages. Credit cards are easily lost, misplaced, and stolen. They are like cash, and since so many people have credit cards today, misuse of them is becoming a serious crime of national import.

Handling the credit card sale is extremely important. You must follow your company's specific rules about these sales. The most serious violations that cause losses for the owner are these:

1. Accepting cards that the company does not recognize or honor. These sales are lost cash to the company since it is unlikely you can collect on them.
2. Accepting cards that have been cancelled by the company for any of several reasons. Most cards are cancelled for nonpayment by the customer, or slow payment. Some are cancelled because they were reported lost or stolen.
3. Accepting restricted cards for payment of unauthorized merchandise. Some credit cards permit authorized purchases for fuel and motor oil only, and only when it is put in the car, and only for the amount of the car's capacity.
4. Accepting out-of-date credit cards that have expired.

Almost every oil company has a chart posted near the sales desk and register showing the cards that will be honored and the authorized purchase power of each card. You must read and become well acquainted with these restrictions. You must also keep posted on company bulletins about credit card use and abuse. A list of credit card numbers that have been cancelled is issued weekly and circulated to all dealers and distributors. You must check the current cancellation list with each credit card sale to make sure the card has not been cancelled or recalled.

A credit card belongs to the company—not to the customer. Therefore, any card that has been reported

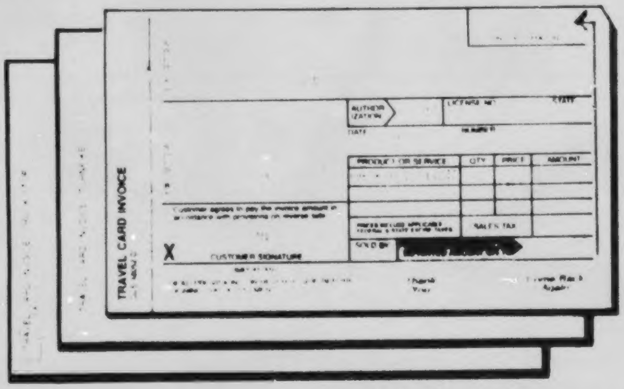

TRAVEL CARD INVOICE
X
CUSTOMER SIGNATURE

Fig. 5-1. Learn how to prepare a credit sale invoice, checking all points for accuracy. (Courtesy Gulf Oil Corp.)

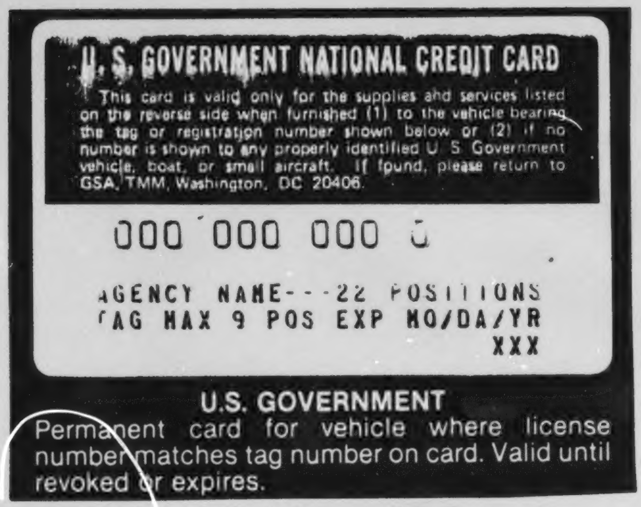
lost, stolen, or cancelled should not be returned to the customer. An out-of-date or expired card should not be returned to the customer. If the customer gets upset or leaves in a hurry when you mention that the card is void, don't try to stop the customer or threaten arrest. Rather, get a description of the car and the license number. Tell your owner or manager immediately, and let him or her handle the situation.

Follow your company's rules on all credit card transactions. When you are not sure or if the rules are not posted, ask for specific rules on accepting credit card sales. Generally, you can use the following information as a guide.

1. Most oil companies honor *only* their own cards, plus the U.S. Government National Credit Card (USGNCC) carried by some federal officials. On the USGNCC, the tag number on the card should match the license plate number on the vehicle. There are restrictions on sales with USGNCC. It may be used for fuel in the car and only for the capacity of the tank and for motor oil in the crankcase for the capacity only. TBA sales are restricted. Emergency purchases of antifreeze, spark plugs, fan belts, wiper blades, and lamps are permissible, but only when installed on the vehicle. When in doubt, consult your owner, manager, or supervisor, or call the company's credit card authorization number.

2. Each company has sales restrictions on credit cards, and nearly all have a maximum amount allowable on each sale. Generally, purchases made on a credit card are for normal automotive products and services, including repairs and road service emergencies. Marine product stations and aircraft product stations may also authorize credit purchases on the same credit cards.

3. Most companies have restrictions on purchases of products or services not performed on the premises or not installed on the vehicle itself. For example, many companies will not permit the purchase of tires unless they are to be installed on the vehicle. Many have maximum amounts allowable on purchases, such as $100 on products or $50 on repairs.



U.S. GOVERNMENT NATIONAL CREDIT CARD

This card is valid only for the supplies and services listed on the reverse side when furnished (1) to the vehicle bearing the tag or registration number shown below or (2) if no number is shown to any properly identified U. S. Government vehicle, boat, or small aircraft. If found, please return to GSA, TMM, Washington, DC 20406.

000 000 000 0

AGENCY NAME---22 POSITIONS
TAG MAX 9 POS EXP MO/DA/YR
XXX

U.S. GOVERNMENT

Permanent card for vehicle where license number matches tag number on card. Valid until revoked or expires.

Fig. 5-2. Know the limitations on a U.S. Government National Credit Card. (Courtesy Gulf Oil Corp.)

4. Accept a credit card from the vehicle owner only. You can trace an owner through the license plate number, but not a passenger's ownership or responsibility.

5. Always check the current credit card bulletin to make sure the card number is valid. If in doubt, call the credit card authorization center for verification.

6. Always check to make sure the card has not expired and that it has a signature. If the card is not signed, ask the owner to sign it. Then match the signature with that on the invoice and against the name on the card.

7. Sell only authorized products approved for credit card sales, and only authorized services. Do not exceed the authorized amounts on these.

8. Make sure the invoice you fill out is complete with all necessary information and is legible. Write down the vehicle license number and state.

9. Set imprinter amount correctly since it must match the written amount on the invoice. Have the customer sign the invoice.

10. Credit invoices are the same as money. They must be treated with care and filed in a safe, secure place. Most companies require that invoices be processed for payment or credit within 14 days of date.

Other precautions about credit cards must be noted. All invoices are numbered and kept in numerical order. If you ruin an invoice, do not throw it away. Instead, write "Void" across it, and file it with the other invoices. In this way, the owner or manager can account for all transactions. A missing invoice cannot be accounted for, and it could be just like missing cash.

Handle invoices with care. Make sure the invoice is placed in the imprinter properly and aligned. Otherwise, the invoice will be torn, improperly printed, or ruined. Look at the carbon copy to see that the customer's name and credit card number are legible. Make sure the company name is shown on the invoice so the oil company can give proper credit.

Private Credit Transactions

In some places, the owner or dealer may personally grant credit to a few, selected customers. These are usually people whom the owner or dealer knows well and is willing to extend credit to for 30 days or longer. In these cases, the owner is taking the risk and not the oil company.

Make sure you follow the owner's wishes and instructions in such cases. Write the invoice as instructed, and file it where it can be processed. Never extend credit without the owner's permission and instruction. Never volunteer credit to anyone else.

Warranties

When new tires and batteries are sold, nearly all carry a limited warranty. It is the salesperson's responsibility to make out the warranty cards, noting the date and odometer mileage of the vehicle. In some cases, a date stamp is used to imprint the battery, or the month and year dates are punched as holes in a warranty card.

Explain the warranty conditions and limitations to the customer. Advise him or her to keep the warranty in the owner's manual, glove compartment, or where it can be found when needed. In most cases, a warranty is not given if a battery or tires are not installed on a vehicle at the time of the sale.

Questions

1. Describe the proper procedure for making change when you have a cash sale.
2. How should you treat a sale paid with a personal check?
3. What kinds of personal identification are acceptable when cashing personal checks or traveler's checks?
4. Name five specific things to look for on a personal check.
5. How do you treat traveler's checks and money orders?
6. Name the most serious violations in handling credit card sales that can cause losses for the owner.
7. What restrictions are placed on the use of a USGNCC card?

Projects

1. Prepare a list of all the credit cards that your company honors, plus the restrictions on purchases and amounts for each card. Do this in the form of a chart with four columns. In column 1, list the card honored. In column 2, list the products that may be purchased. In column 3, list the restrictions on the products themselves. In column 4, list the maximum amount of purchase allowed.
2. Write a report answering the following questions: How are credit card authorizations handled at your training station? Who can authorize in case of doubt? Is there a central credit authorization number to call? What do you do if a customer gives you a credit card that is on the list of cancelled cards? How do you proceed in this situation, particularly if fuel has already been put in the vehicle?
3. Describe any forms of credit offered by your company other than company credit card or bank credit card.

6

Job Health and Safety

Objectives: After completing this assignment, you will be able to—

1. state the basic safety rule;
2. list the places, tools, equipment, and potential safety hazards in a service station or tire and battery sales and service business;
3. describe the five basic health rules that apply;
4. identify the potential hazards relating to storing and handling explosive or combustible materials; and
5. identify the potential hazards of hydraulic lifts, jacks, power tools, portable tools, ladders, and air compressors.

A service station or any petroleum marketing operation has certain health and safety hazards that you should be aware of. Any business that sells and services automobiles, including tires, batteries, and accessories, has certain health and safety precautions to be observed. Your employer is expected to furnish you with a safe place to work. However, the matter of your personal safety and health is largely a matter of how well you observe safety rules and regulations. It does little good to think about safety *after* an accident. Your own safe habits protect not only yourself, but also your fellow workers.

The Basic Safety Rule

Working around gasolines and other explosive motor fuels is always potentially dangerous. The equipment and tools used on automobiles are also potentially hazardous. The basic safety rule to be constantly observed is this: **AN UNSAFE CONDITION + AN UNSAFE ACT = DISASTER.**

Take away unsafe conditions and take away unsafe acts, and you can almost eliminate accidents, health hazards, and dangers. You can make your workplace as safe as any provided you are aware, alert, and practice safe work habits.

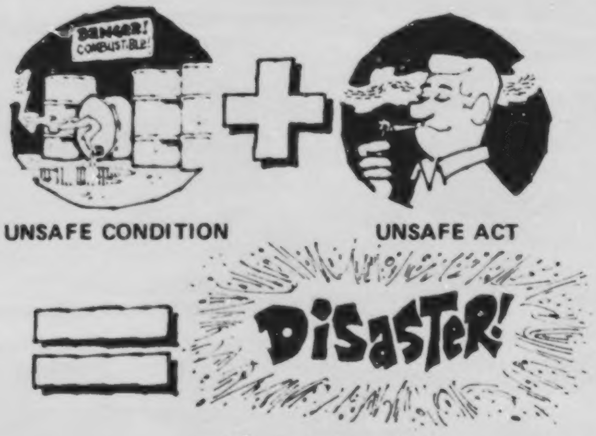


Fig. 6-1. Basic safety rule

Safety Awareness

Safety is largely a matter of attitude. If you have a good attitude about safety and are aware of the potential hazards and dangers, then you are less likely to have an accident. Safety awareness becomes such a habit that you know the safety rules and practice them constantly. As an employee, you have these responsibilities:

- Know and observe all rules concerning safe practices during all types of operations.
- Know the protective equipment to wear during certain operations, such as safety goggles, gloves, or shoes.
- Know the emergency procedures to follow in case of danger or accident.
- Know the location of all fire extinguishers and first-aid kits, and how to use them.
- Look for warning and danger signs, and observe them.
- Never operate equipment without knowing how and without ob-

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Information in this assignment is taken from *NIOSH Health and Safety Guide for Service Stations*, published by U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health, Cincinnati, Ohio, February 1975.

serving the proper precautions, and never operate unsafe or damaged equipment.

- Observe good housekeeping rules.
- Wash your hands often to prevent infections and to ensure safe handling of tools and equipment.
- When mixing electrolyte (battery acid), you *always pour the acid into the water*—not the water into the acid.
- Make sure that all hazardous materials are properly stored—in the right containers, in the right places, and under the right conditions.

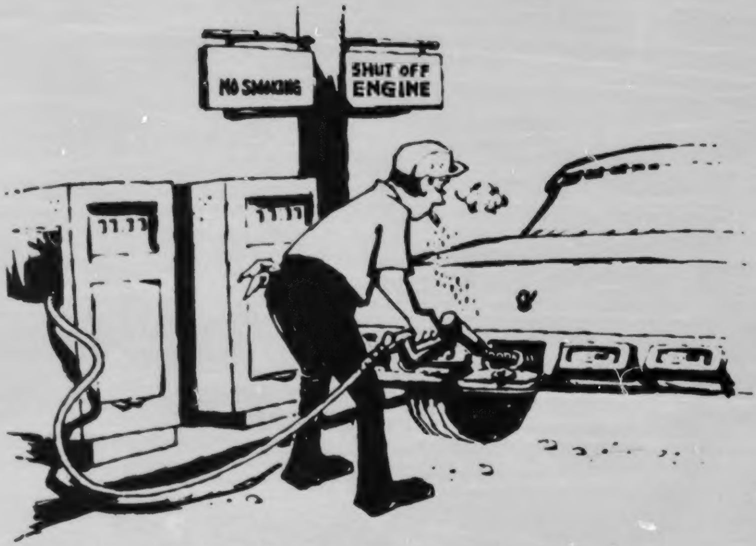


Fig. 6-2. Observe "No Smoking" rule around pump islands.

Safety Guidelines

Pump Island Area

- Always observe the "No Smoking" rule.
- Make certain the engine is shut off before starting delivery from the pump.
- See that all pump hoses are safely out of the way when not in use. Hose retractors must be in proper working order.
- Remove any tools, equipment, or other objects from the driveway or pump island area that could trip or injure either workers or customers.
- Have adequate lighting in the pump island and driveway areas.
- Know the location of the emergency cutoff switch for all fuel pumps.
- Report immediately any damaged or inoperable equipment connected with the fuel pumps, hoses, connectors, nozzles, or shutoff devices. Do not use the equipment until proper repairs have been made.

Power Tools

- Each electrical power tool has its limitations, uses, and potential hazards.
- Select the proper tool for the job, but never use a tool unless you have been given instructions in its safe use and operation.
- Never use a damaged or unsafe tool.
- Never use an electrical power tool that is not properly grounded, has a frayed cord or damaged couplers, or has excessive arcing or sparking when turned on.
- Never use a tool in an area that is wet or has water on the floor, or when you have wet clothing or hands.
- Use safety goggles, dust masks, and other protective clothing when operating grinding, chipping, painting, or sanding equipment.
- Remove adjusting keys and wrenches before turning on power tools.

Service Bays

- Never stand under a hydraulic lift that is being raised or lowered.
- Never operate lift equipment without proper instruction and use of safety devices.
- No one may be inside a vehicle that is being raised on any kind of lift device.
- Make sure all vehicle doors, trunk lids, and hoods are closed before lifting the vehicle.
- Make sure vehicle is properly positioned on the lift, that safety chocks are in place, and that vehicle is not near either end of the rack.
- Know the load limits of all lifts, and never overload them.
- Make certain all locking devices are engaged before walking under or working under a hoisted vehicle.

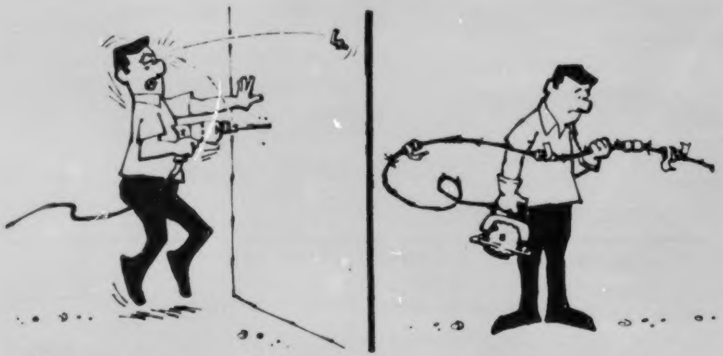


Figure 6-3

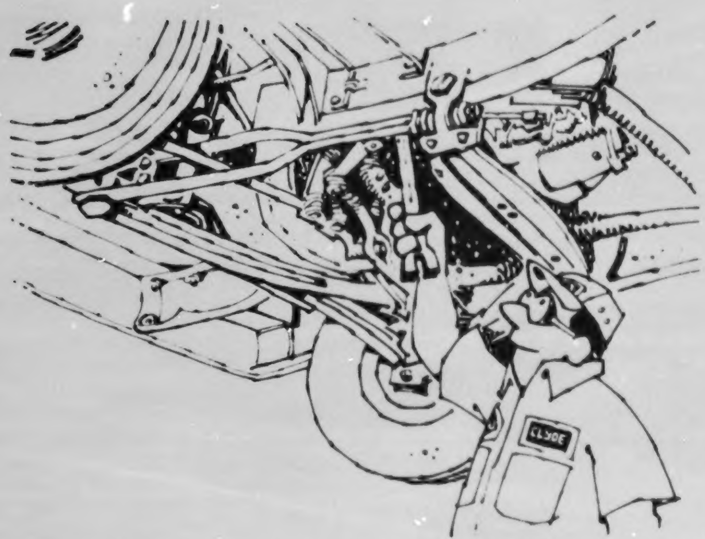


Fig. 6-4. Eye protection is needed when working under cars.

- Never operate an unsafe or malfunctioning lift, or one that has these faults:
  - Jerks or jumps when being raised.
  - Slowly settles down after being raised.
  - Slowly rises when not in use.
  - Comes down very slowly.
  - Shows signs of severe oil leakage, or blows oil out of the exhaust line.

Tire-Changing Equipment

- Never change a tire on a split rim without using a safety tire rack or cage.
- A tire cage is required when changing or repairing any truck tire.
- Never use automated tire-changing equipment without proper instruction.

Tow Trucks

- All tow trucks and road service vehicles should be equipped with a fire extinguisher that is easily accessible, in good working condition, and securely mounted.
- Never exceed maximum load limit of hoist and winching equipment.
- Never paint over or remove the manufacturer's data plate on the capacity of the winch mast.
- Proper lighting for nighttime use must be in working order.
- The tow truck should be equipped with safety flares and wheel chocks.
- Make frequent inspection of all control mechanisms, safety devices, and hooks.
- Hooks and all structural members of hoist crane must be free of cracks and warped shape.
- Check for worn or misshapen pins, bearings, shafts, gears, or locking devices; excessive cable wear, fraying or broken cable strands, kinks or bends; and corroded connectors.
- Never work under a vehicle that is supported only by a cable hoist.

All Working Surfaces

- All walk areas, corridors, storerooms, service areas, offices, and sales rooms must be kept clean, free of trash and litter, with clean, mopped, dry floors.
- Spills, leaks, or anything that might cause falls must be cleaned up immediately.
- Areas that are frequently wet should have nonslip surfaces.
- All aisles and passageways must be kept free of boxes, displays, signs, tools, equipment, or anything that blocks free movement.
- Know the floor-load capacity, and never exceed that with stored merchandise, equipment, or fixtures. The capacity is usually expressed in pounds per square foot.

Ladders

- A fixed ladder must support a load of at least 200 pounds.
- No ladder should have rungs over 12 inches apart. Metal rungs must be at least ¾ inch in diameter, and wooden rungs must be at least 1⅛ inches in diameter.
- All *fixed* or permanently mounted ladders must have—
  - painted surfaces to protect against rust and corrosion;
  - safety cages if longer than 20 feet;
  - toe clearance of 7 inches in back of ladder;

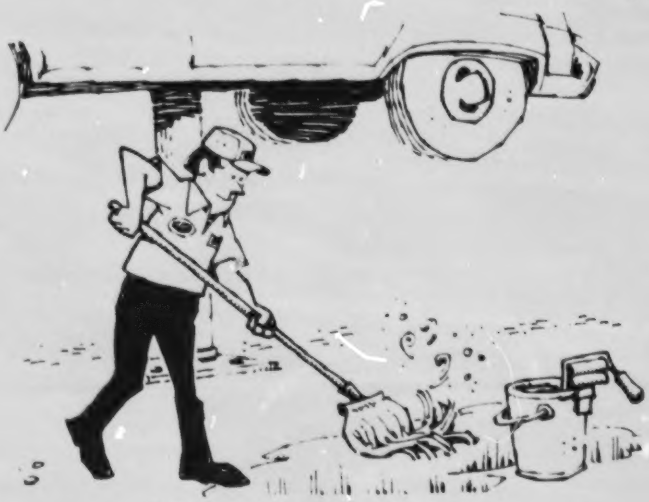


Figure 6-5

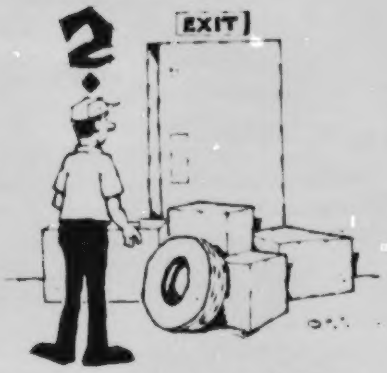


Fig. 6-6. *Never let anything block an exit.*

  - clearance of 2½ feet on climbing side.
- All *portable* ladders must—
  - be in good condition at all times—never use a ladder that has splits, warps, bent or missing rungs, or otherwise appears unsafe;
  - be inspected frequently for signs of wear or structural damage;
  - be stored in a proper location where they will not fall or hang over working areas;
  - have secure footing when in use and not be placed on any unstable surface.

Stairs

- The rise height and tread width must be uniform throughout any set of steps or stairs, regardless of material.
- All treads must be slip-resistant.
- Vertical clearance over steps and stairways must be at least 7 feet.
- The minimum permissible width is 22 inches.
- All stairways must be adequately lighted at all times.
- Nothing may be stored on any step or stairway that obstructs vision or safe walking. No tools, cleaning equipment, or anything may be left on the stairs or steps that will cause tripping.
- All platforms or structures with an open side must have a suitable safety railing. All stairs must have at least one handrail securely mounted.

Exits, Doorways, Emergency Areas

- Every exit must be plainly marked "EXIT," in letters at least 6 inches high.
- Any locked door must be plainly marked "NOT AN EXIT." Any room that is not an emergency exit should be so marked, such as "STOREROOM ONLY" or "TO BASEMENT."
- Nothing may block or hamper access to an exit or emergency exit.
- All doors must be of the free-swinging type that opens to the outside, and nothing may block the free opening of such doors.

Compressed Air Equipment

The air compressor itself is frequently abused and improperly maintained. You should check the following on a regular basis:

- Pulleys and belts must be completely guarded; electric motors must be guarded.
- Deterioration of electrical cords to motor must be checked.
- The drain valve should be opened often to prevent excess liquid buildup.
- Relief valves must be inspected and tested at regular intervals.
- Never use compressed air to blow dirt off clothing or skin—this can be extremely dangerous if you have a cut or abrasion.
- There must be no valves between the air tank and safety relief valve.
- The pressure controller and gauge must be in good condition and tested periodically.

Machine Guards

Almost all types of stationary power tools and equipment should be equipped with guards. These are the most important safety devices there are. They get left off when machines are taken down for cleaning and repairs. Often, employees carelessly remove guards or fail to put them in place. All of the following require machine guards:

- Power transmissions.
- All moving parts that are exposed.
- Point-of-operation hazards, such as cutting blades, knives, grinding wheels, and sanders.
- All belts, pulleys, chains, sprockets, and gears.
- All belts, chain drives, shafts, couplings, keys, collars, and clutches located 7 feet or less above ground or working platform; V-belts and chain drives must be completely enclosed.

Specifically, the following tools must have these guards at all times while operating:

- *Table top grinders* must have wheel guards, eye shields, work or tool rests, and adjustable tongue guards.
- *Bench grinders* must be permanently mounted.
- *Goggles* or *face shield* must be worn by operator at all times.
- *Fans* must have grille or mesh guards with openings no more than ½ inch.
- *Air compressors* must have flywheel and drive pulleys completely enclosed.

Hand and Portable Power Tools

Employees should never use damaged hand tools. These include hammers with broken heads and handles, chisels and punches with mushroomed heads, bent or broken wrenches, or any tool that appears bent or cracked.

All hand-held electrical power tools must be equipped with a "dead man" switch that shuts off power as soon as the control is released. Any portable power tool operating at more than 90 volts must have its frame grounded by a separate ground wire or be doubly insulated.

Jacks

Jacks are often one of the most carelessly used pieces of equipment in a service station or auto accessory business. Unless the jack is securely positioned on a dry, smooth surface and absolutely perpendicular to the load, there is a danger of the car falling off the jack.

In addition, each jack should be routinely inspected for damage or malfunction. Never overload a jack beyond its rated load. Cars on jacks must be cribbed, blocked, or secured at once.

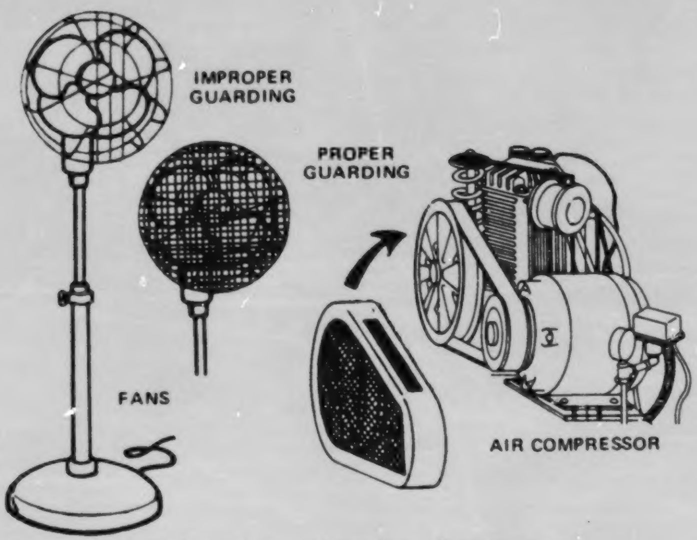


Fig. 6-7. Use the proper guards on all equipment.

Welding, Cutting, and Brazing Equipment

- All cylinders must be away from radiators, furnaces, and other sources of heat.
- All cylinders stored inside buildings must be in a well-ventilated, dry location at least 20 feet from combustible materials, and away from elevators, stairs, and gangways. They should never be kept in unventilated enclosures or locked away in storerooms.
- Cylinder caps must be in place when not in use.
- Stored oxygen cylinders must be separated from stored fuel gas cylinders or combustible materials (motor oils, lubricants, and solvents) by at least 20 feet.
- All cylinder valves must be closed when work is finished.
- All cylinders must be legibly marked to identify contents.
- No cylinder may stand alone without being secured, to prevent it from toppling over.
- Acetylene must not be used at a pressure in excess of 15 psi gauge, or 30 psi absolute.
- Indoor storage of compressed gas is limited to a total capacity of 2,000 cubic feet or 300 pounds of liquified petroleum gas.
- Individual booths or noncombustible screens must be provided to enclose the welder.
- Proper eye protection must be worn by welders, when welding, cutting, or brazing, and by any other person exposed to the flash.
- Respirators should be worn when welding or cutting in confined spaces or cutting through leaded joints.
- Hoses showing leaks, burns, or worn places must be replaced.
- Cutting or welding is not permitted when explosive fumes are present.

Common Health Hazards

Carbon Monoxide

Any petroleum combustion produces carbon monoxide as a by-product. It is a tasteless, odorless, *deadly* gas. In tight areas with restricted airflow, it can cause unconsciousness and death in a matter of minutes. Never work in an enclosed space with a vehicle's engine running unless the exhaust gas is being removed by a special exhaust system.

Any heating system using natural gas, coal, or other petroleum products must be inspected frequently for gas leaks and proper burning. All heating equipment must be properly vented.

Asbestos

Brake repair exposes you to asbestos fibers. The dust from worn brake linings, and equipment which grinds brake shoes and drums, forms excessive asbestos levels in the air. To reduce the risk, always wear a dust mask. Vacuum—never blow—the brake dust from linings and drums.

Combustible Liquids and Fumes

In addition to the hazards of fire and explosion, nearly all petroleum products have noxious fumes that are hazardous to your health. These include gasolines, diesel fuels, paints, thinners, solvents, and many oil products.

- Keep all combustible liquids stored in proper containers, with approved ventilation devices.
- All storage rooms for combustible materials must have explosion-proof lighting and switches.
- When transferring flammable liquids from one container to another, make sure they are properly connected to each other and to a ground.
- Clean up spills immediately.
- Rags and waste materials must be stored in a covered metal container and disposed of daily.
- Never use gasoline as a cleaning agent.

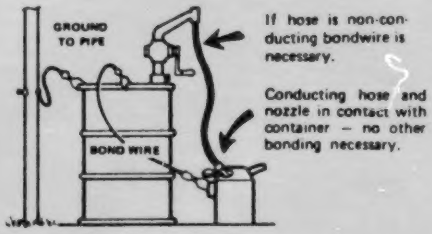

GROUND TO PIPE
BOND WIRE
If hose is non-conducting bondwire is necessary.
Conducting hose and nozzle in contact with container — no other bonding necessary.

Fig. 6-8. Observe safety rules when transferring combustible liquids.

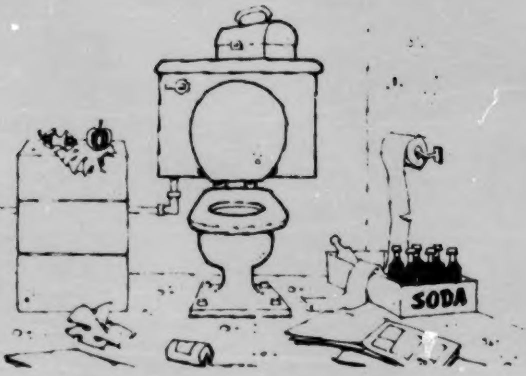


Fig. 6-9. Do not store food or beverages in rest rooms.

Sanitation

- Never use a common drinking cup or glass, including coffee mugs.
- Where food products are consumed, a covered container must be provided for their disposal.
- Any rest room—public or private—must be kept in a clean and sanitary condition.
- Any toilet or rest room must be provided with an operating lavatory or wash basin. Employees must be instructed to wash their hands often during the workday to remove dirt, grease, oils, and other chemicals that may cause skin rash or infection.
- Employees may never eat or drink in a rest room or toilet area.
- No food products—including bottled or canned drinks—may be stored in a rest room or toilet area.

First Aid and Medical Emergencies

- At least one person should be on duty at all times who knows how to render first aid. It is a good investment for every employee to know first aid and to have taken an approved course offered by the Red Cross, National Safety Council, or any of several organizations.

- Know the location of first-aid kits. Make sure they have adequate supplies.

- Any kind of cut, scratch, injury, accident, burn, or exposure to toxic chemicals or fumes should get immediate and competent treatment, and medical attention if necessary.

Questions

1. What is the basic safety rule?
2. What rule is followed in mixing electrolyte?
3. Why is washing your hands often a good safety rule?
4. What precautions are to be observed in using electrical power tools?
5. What actions indicate an unsafe or malfunctioning hydraulic lift?
6. What special precautions must be observed in changing a tire on a split rim or a truck tire?
7. What conditions do you check when using portable ladders?
8. What guidelines apply to the use of an air compressor?
9. What pieces of equipment require machine guards before being used?
10. Name five areas that present common health hazards on the job.

Projects

Complete one of these.

1. Prepare a list of all the unsafe and hazardous conditions present at your training station. Break these down into specific areas, using those given in the assignment. This list should be made to be presented to your training sponsor, but only with the consent of your teacher-coordinator.
2. Prepare a poster on any *safety theme* of your choosing that applies to your training station. You may use the basic safety rule, operating equipment, or any other condition, tool, equipment, or unsafe practice.

7

What You Should Know about Gasolines

Objectives: After completing this assignment, you will be able to—

1. explain why gasoline is a desirable motor fuel;
2. name three qualities that gasoline must have to be an efficient motor fuel;
3. explain what octane rating means and how it affects engine performance; and
4. name seven important additives put in gasoline that improve performance.

Gasoline as a Motor Fuel

All of today's automobiles are powered by an internal-combustion engine that uses either gasoline or diesel fuel. To refresh your memory, an internal-combustion engine uses an enclosed cylinder and a piston to generate power. A mixture of air and gasoline is drawn into the top of the cylinder and is compressed. A spark plug ignites the mixture, and it burns rapidly. As it burns, it expands and pushes against the piston. All of the power inside an engine comes from this compressing-igniting-burning-expanding process. The only fuel that will produce this power is either gasoline or diesel fuel—both petroleum products.

Diesel fuels are discussed in Assignment 8. This one is only about gasoline. Most retail stations today market at least three grades of gasoline—*premium, regular,* and *unleaded.* The first two contain lead compounds, and the latter has either very low lead compounds or none at all.

Gasoline from Crude Oil

Gasoline comes from crude oil. In the refinery, the crude is broken down, providing many different products. These include kerosene, jet fuels, home heating oils, lubricating oils, motor oils, greases, and wax. In the catalyst where crude is broken down, gasoline is at the top as the lightest form of the mixture. Chemically, gasoline is a mixture of carbons and hydrocarbons. This is raw gasoline. Other compounds and chemicals are added to it to make it acceptable as a motor fuel. Today's automobile engines are more demanding and harder working than ever before. It takes a modern gasoline to fuel the engine and wring every ounce of energy it can from each drop.

Why use gasoline as a motor fuel? One of the important properties gasoline has is its ability to vaporize rapidly. By that we mean that gasoline as a liquid will not burn. It will burn only as a vapor. But gasoline cannot be stored as a vapor—it must be stored in liquid form. To properly use the gasoline as a fuel, the engine is equipped with a carburetor. The carburetor takes liquid gasoline and mixes it with air. This turns it into the vapor needed by the engine. As this air-gasoline mixture is drawn into the cylinder, the piston comes up and compresses it into a small space. The spark ignites the mixture, causing it to burn rapidly. It is the rapid burning that causes the mixture to expand, driving the piston downward. That is the only source of energy or power that the engine develops.

So gasoline has these important ingredients as an energy source:

1. Gasoline vaporizes quickly to create rapid burning.
2. Rapid burning creates heat, which causes expansion to develop power.
3. Even at today's cost of gasoline, the energy developed is extremely economical—when you consider the work it must do.
4. Improved qualities in refining and chemicals added to raw gasoline make it act as a self-cleaner to all internal engine parts.

Gasoline Qualities

Are all gasolines alike? Definitely not! In addition to vaporizing and burning rapidly to create energy, gasolines must do many other things. Gasoline quality comes from the refining process and the additives.

First, a gasoline must be able to vaporize rapidly in cold weather and have a retarded vaporizing action in hot weather. This quality is called the *volatile index.* In cold weather, the chilled air slows down the vaporizing and helps create ice crystals. The ice can form in the carburetor, blocking the flow of proper air-gasoline mixture into the cylinders. A good gasoline must be able to prevent ice formation and vaporize even with chilled air. In hot weather, the gasoline must not vaporize too quickly. If it does, vapor lock occurs, and the engine will not run properly. It will stall or fail to start.

Second, because gasoline comes from crude oil, it has a tendency to form a sort of gum or varnish on the metal surfaces it touches. A good gasoline will not form gummy residues. Added detergents help the gasoline clean metal parts.

Third, a good gasoline promotes rapid starting and fast engine warmup. The faster the engine turns over and starts, the less electrical drain on the storage battery. The faster the warmup, the more efficient the engine uses the energy from the gaosline. A "cold" engine uses more gasoline because it requires a richer mixture of gasoline and air. When an engine is "cold" and uses the richer mixture, much of the gasoline does not burn up. The unburned portion forms what is called *blow-by*. It enters the crankcase in the form of moisture and dilutes the lubricating oils. Thus, a good gasoline gives quick warmup to the engine so that moisture and contaminants are kept at a minimum.

Octane Measurements

One of the most important qualities of a gasoline is its **octane rating.** What is octane, and what does it mean? The term *octane* is a laboratory measure that determines the *antiknock quality*. It is expressed in numbers. When an engine is running hot, is put under strain, or is under rapid acceleration, you will hear a knock or ping in the engine. What is happening is that the gasoline-air mixture is firing too quickly—producing the knock or ping in the cylinders. The higher the compression ratio of the engine, the more likely the knock. Occasional knock does not damage the engine. The driver is more annoyed than anything else. However, a sustained knock or ping means that a higher octane gasoline is needed.

The octane number that appears on the gasoline pump comes from two different measurements. In a laboratory, the gasoline is first run through a series of tests in a single-cylinder engine. The test run is at low revolutions per minute (rpm) and at a fairly low operating temperature—usually around 120°F. The engine is constructed so that compression ratios can be run up or down as the engineer wants. The antiknock quality is then given a performance number. For example, on a grade of "regular" gasoline, the *research octane number* will probably be 93. But this test is not considered accurate, so another controlled test is made. The engine is put through an actual road test where the engine is running at about 900 rpm and the temperature is around 300°F.

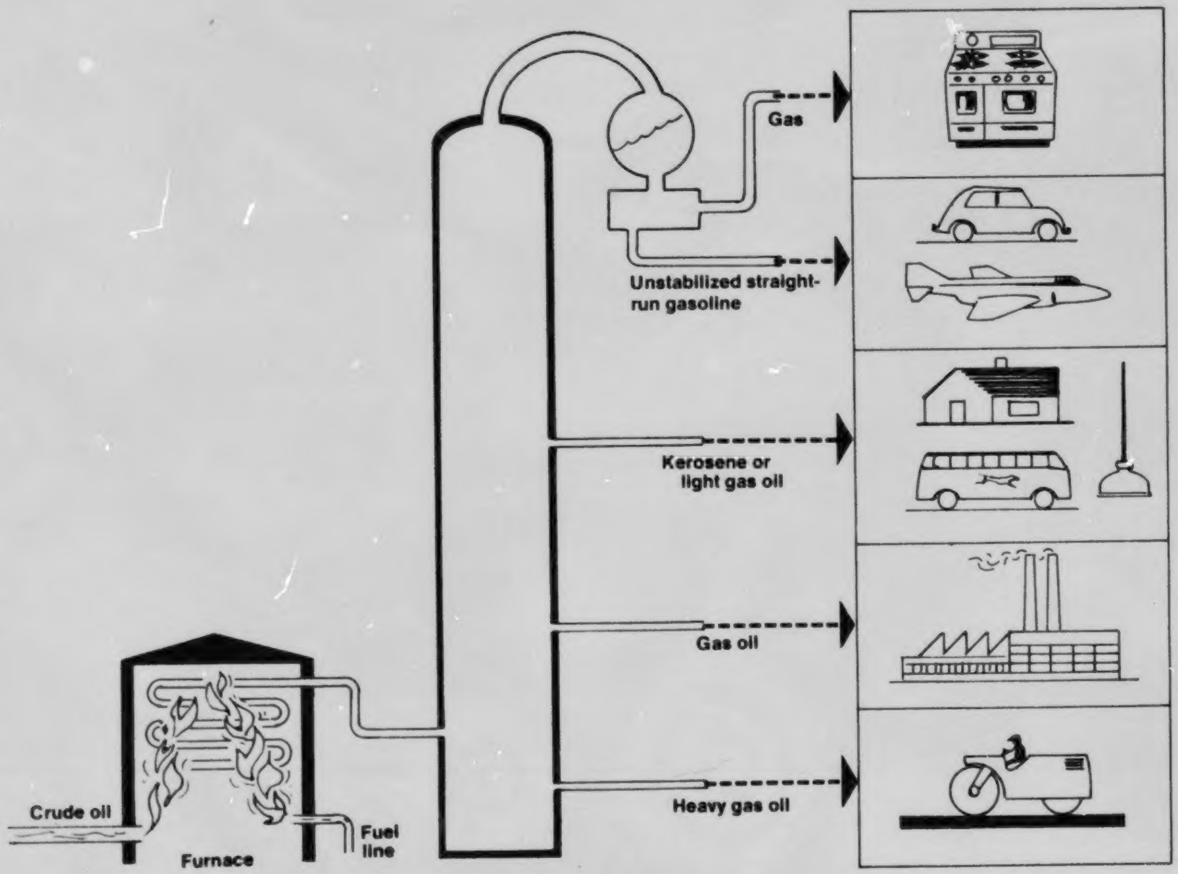
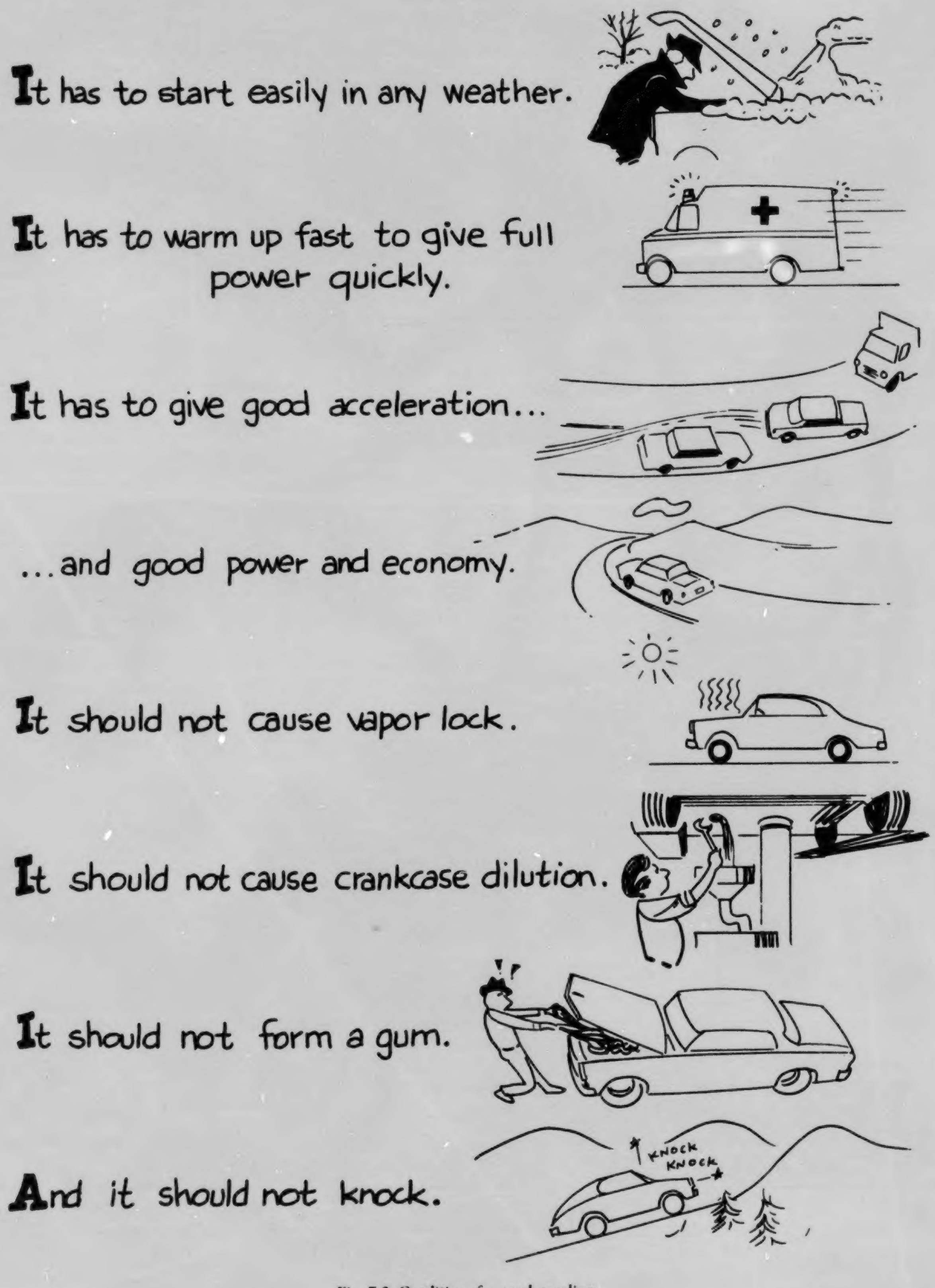


Fig. 7-1. Gasolines and diesel fuels come from crude oils. They are drawn off near the top of the refining process.



It has to start easily in any weather.

It has to warm up fast to give full power quickly.

It has to give good acceleration...

...and good power and economy.

It should not cause vapor lock.

It should not cause crankcase dilution.

It should not form a gum.

And it should not knock.

Fig. 7-2. Qualities of a good gasoline

Here, the antiknock quality will be somewhat lower—say, 85 octane. This is called the *motor octane number*.

Today, the Cost of Living Council has declared that the octane rating of a gasoline must appear on the pump as a number that is the average of both the research number and the motor octane number. The formula is R + M/2. In the above example, the octane number shown on the pump would be 89.

What Does Octane Mean to the Customer?

Many customers think that the higher the octane, the better the quality. This is not true. The octane refers only to antiknock quality. There is no advantage in using a gasoline of a higher octane than the engine requires. Another common misconception is that higher octane gasolines are more powerful. Again, octane refers only to antiknock quality. It has nothing to do with the ability of the gasoline to vaporize.

A customer should buy a gasoline that has an octane number recommended by the automobile manufacturer. This rating is usually given in the owner's manual. However, as some engines begin to wear or build up carbon deposits, they may begin to knock or ping. A higher octane number will usually correct the problem. If the engine chatters, pings, or knocks quite often—even with a higher octane gasoine—then it has a mechanical problem. The timing may be off and need adjustment.

Generally, *premium* gasolines have the highest octane ratings because they are made for high compression and high performance engines. *Regular* gasolines have medium-range octane numbers and are the most widely used in most of today's engines for 1974 models and older. All American-made automobiles from 1975 on have engines that require the use of *unleaded* gasolines. The lack of lead compounds in unleaded gasoline reduces the octane number. This means that unleaded gasoline is less effective than premium or regular grades in preventing knock and ping.

If a customer complains of low power or excessive knock with unleaded gasoline, recommend a grade with a slightly higher octane number. A few oil companies market a "super unleaded" or "supergrade unleaded" gasoline with an improved octane rating.

Many foreign automobiles—particularly the compacts with small four-cylinder engines—can use regular gasoline because of improved emission controls. Any automobile that is restricted to unleaded gasoline will have a smaller filler neck in the gasoline tank tube, and the regular or premium grade nozzle will not fit it. This is one method used to make certain these tanks are not filled with the wrong gasoline. Most American-made automobiles from 1975 on are equipped with a catalytic converter. The use of leaded gasoline will "poison" the converter, making it ineffective.

Gasoline Additives

Raw gasoline as it comes from the cracking process is not suitable for use in most of today's automobile engines. As mentioned, an *antiknock compound* is added to achieve proper octane rating. This is usually a chemical compound called *tetraethyllead* or the newer compound *tetramethyllead*. Both provide antiknock protection.

A second important additive is a *deposit modifier*. When gasoline mixtures are fired in the combustion chamber of the engine, certain deposits form on the rim of the spark plug. When these build up, they reduce the gap between the tip and the sidewall, causing misfiring. These deposits build up heat and will cause the gasoline-air mixture to fire before the piston reaches top dead center. This reduces the power and destroys the timing, and the engine runs rough and uneven. A chemical compound in the gasoline retards this deposit in the combustion chamber and on the spark plug.

A third important additive is an *antioxidant* (meaning to delay oxidation). When gasoline is stored, it has a tendency to form a gum or varnish. This comes from the antiknock and deposit modifier compounds that have been added. The type of crude oil, the refining process, and the temperature at which gasoline is stored all have an effect on the amount of gum formed. The antioxidant compound combats the gum or varnish formation that would quickly form on all surfaces the gasoline touched.

A fourth additive *fights traces of copper* that can get into gasoline during refining and distribution and through the automobile's gasoline feed system. The copper cannot be seen as it usually is in dissolved particles. But its presence in gasoline will cause rapid oxidation with gum and sludge deposits. Unless the copper particles are deactivated, the gasoline will foul the entire combustion and carburetion process.

A fifth additive is an *antirust agent*. Since gasoline vaporizes rapidly, it absorbs heat from the air. That is why gasoline always feels so much colder than other liquids. While in storage, the cooling process creates water vapor and condensation. Condensation will form in the gasoline tank, in the fuel lines, and in the carburetor. All this moisture will eventually create rust and corrosion of metal parts.

A sixth additive is an *anti-icing agent*. In very cold weather, the gasoline's vaporizing creates moisture in the formation of condensation. Without an antifreeze, ice would form in the carburetor and in the fuel lines. These ice crystals will foul or clog the free passage of the gasoline liquid and vapor, causing stalling and hard starting.

A seventh necessary ingredient is a *detergent*. This actually helps the gasoline clean delicate moving parts in the carburetor. Without a detergent, gums, sludge, and varnish will soon coat the parts, slowing the fuel economy and overall performance of the engine.

Better grades of gasoline have an *upper cylinder lubricant*. This helps prevent ring and valve sticking. It is even more important in unleaded gasoline. The absence of lead—itself a lubricant—can create valve problems. Upper cylinder lubricants can relieve the problem.

When the customer drives up to the pump, it is not necessary to tell him or her all of the additives in the gasoline. However, this knowledge can lead to a selling point for customers who complain about price or who think all gasolines are alike regardless of brand name. Cheaper motor fuels may not have many of the additives and may have a lower octane rating. If the customer complains of a penny or two per gallon, simply ask if he or she can afford extensive engine repairs from using the lower-quality fuels.

Questions

1. Why is gasoline a desirable motor fuel for the internal-combustion engine?
2. Name three important qualities in a gasoline.
3. Explain the importance of octane rating in gasoline.
4. Explain the difference between the research octane number and the motor octane number.
5. Why do we have grades of gasoline, such as premium, regular, and unleaded?
6. Name seven important additives in gasoline, and briefly tell what each does.

Project

From your local refiner or supplier, find out what important additives are found in the gasolines you sell. At the present time, approximately what percentages of gasoline sales are premium, regular, and unleaded? Compared with a year ago, which one is increasing most rapidly in sales? What is being done to improve the quality of unleaded gasoline in your area? Make this in the form of a brief report, and attach it to the assignment.

8

What You Should Know about Diesel Fuels

Objectives: After completing this assignment, you will be able to—

1. tell how the diesel engine differs from the gasoline engine;
2. define *pour point, cloud point,* and *cetane number,* and explain their importance;
3. describe the three grades of diesel fuel, and tell where each is used;
4. discuss the causes of poor performance in a diesel engine; and
5. tell what is the greatest danger in dispensing different fuels at a service station.

The diesel engine—once thought of only for heavy machinery and big trucks—has now come to the family automobile. It is predicted that the diesel engine will gradually take a larger portion of the internal-combustion engine sales.

Basically, the diesel engine differs from the regular gasoline engine only in the fuel used and the combustion. The gasoline engine uses a spark plug to ignite the fuel mixture. The diesel engine ignites the fuel strictly by compression and heat. No spark plugs are needed.

Fuel is injected into each cylinder by a pump rather than through the conventional carburetor system. For that reason, diesel fuel must have three important qualities: (1) cleanliness, (2) free-flowing at all temperatures, and (3) proper cetane number.

Because the fuel is pumped under pressure to each cylinder through an injection system, there must be nothing to foul or clog the lines or the spray nozzles. The dirt and water that may find its way into diesel fuel can quickly ruin the entire combustion chamber and pistons.

At very low temperatures, diesel fuel must flow as rapidly as it does when hot. This quality is measured by either pour point or cloud point. *Pour point* is the temperature below which the fluid will no longer flow. *Cloud point* refers to the temperature at which wax particles begin to form. The place at which diesel fuel is distributed will have different pour points and cloud points. In hotter temperatures, they are not important, but in cold climates, they are absolutely necessary.

The *cetane number* refers to ease at which the fuel will ignite in the combustion chamber. Again, in lower temperatures, diesel fuels may not have the desirable quick starting and fast warmup qualities. The higher the cetane number, the better the starting capacity of the fuel. However, like octane in gasoline, there is no benefit in using a cetane number higher than that called for by the engine.

Qualities and Grades

Are all diesel fuels alike? No. Diesel fuels cannot be made to one uniform standard. All crude oils are not the same grade and quality, so the fuels refined from them will be different. Not all diesel engines are alike, and they all perform under different loads and climates. Each engine design requires different qualities and grades of fuel. Fuels made for subzero temperatures are quite different from those made to operate under hot, humid conditions. To make them all alike and to one standard would make the fuels so costly that they would no longer be economical.

Diesel Grades

The American Society for Testing and Materials (ASTM) classifies diesel fuels by *volatility*—ability to ignite and burn—and by *boiling point.* Three grades are used today.

Grade 1 D covers the lowest boiling range and most volatile diesel fuels from kerosene to intermediate distillates. This grade also has the lowest cloud and pour points. It is necessary in high-speed engines with a wide variety of load ranges and much stop-and-go work. This grade can also be used in low temperatures where the flow rate is critical.

Grade 2 D comes from the distillates with a higher boiling range. This grade also has a higher cloud and pour point than grade 1-D. It is suitable for high-speed engines carrying heavy loads at uniform speeds—such as highway trucks. It is not suitable for extremely cold weather. This grade is most commonly used in automobiles, long-haul trucks, construction equipment, farm tractors, and railroad locomotives.

Grade 4 D has a very high boiling range and is heavier. It has a much higher flow rate and can only be used in higher temperatures. Its application is for low-speed engines with loads that do not vary and that run at constant speeds. This fuel is ideal for large high-output stationary engines, such as those that operate water pumps for irrigation and those in ships and marine equipment.

Diesel Qualities

Like gasolines, diesel fuels are of varying qualities—mainly because of the refining process, the quality of the crude oil, and the length of time that the fuel has been in storage. Also like gasolines, diesel fuels must have certain additives to make them perform better and be more efficient. It is important to note that no one fuel will have all of these additives. Some will have none because they are not needed for a particular use and engine design.

Ignition quality (cetane) is added when the refined diesel fuel is too low in volatility.

Oxidation retarders are used to prevent deterioration during storage, and the formation of gums and sludge.

Detergents are added to prevent fouling and clogging of the fuel injectors and pumps.

Rust preventives help prevent moisture from clogging and ruining precision parts. Like gasolines, diesel fuels in storage will eventually collect some moisture through condensation and seepage from outside air.

Smoke suppressants help control the amount of smoke from the exhaust system. Heavy white smoke is the result of unburned fuel and happens when the engine is running cold. The heat buildup is not sufficient during warmup to burn all the fuel. Heavy, black smoke indicates a mechanical problem—possibly a fouled fuel injector—or heavy overloading and strain on the engine. Blue-gray smoke indicates oil burning and means worn rings on the pistons.

Dyes may be added to change or brighten the color of diesel fuel. It is for identification only and has no effect on the fuel itself or its performance.

Pour depressants are necessary for some climates and some operating requirements of diesel engines.

Fuel marketers have to carefully consider the needs of all their users and customers when blending diesel fuels. The climate, temperature, applications of diesel engines, and types of engines being served are all considered.

Causes of Poor Performance

Assuming the customer is using the right grade of diesel fuel and that the fuel has been blended properly for the region, the customer may still complain of poor performance. This is nearly always caused by dirty or contaminated fuel. *Water is the number one enemy.* Some moisture is unavoidable because of condensation. However, most water comes from improper storage and handling. Water in the diesel fuel clogs the injector pump and nozzles, causing stalling or hesitation, poor performance, and loss of power.

Careless handling of diesel fuel is another cause of contamination. Fuel tank caps, dispensing nozzles, and hoses must be kept clean. Water gets into storage tanks through faulty vent pipes and fill pipes. In very cold weather, ice crystals will form in diesel fuel, creating clogs. In such cases, small quantities of alcohol can be used

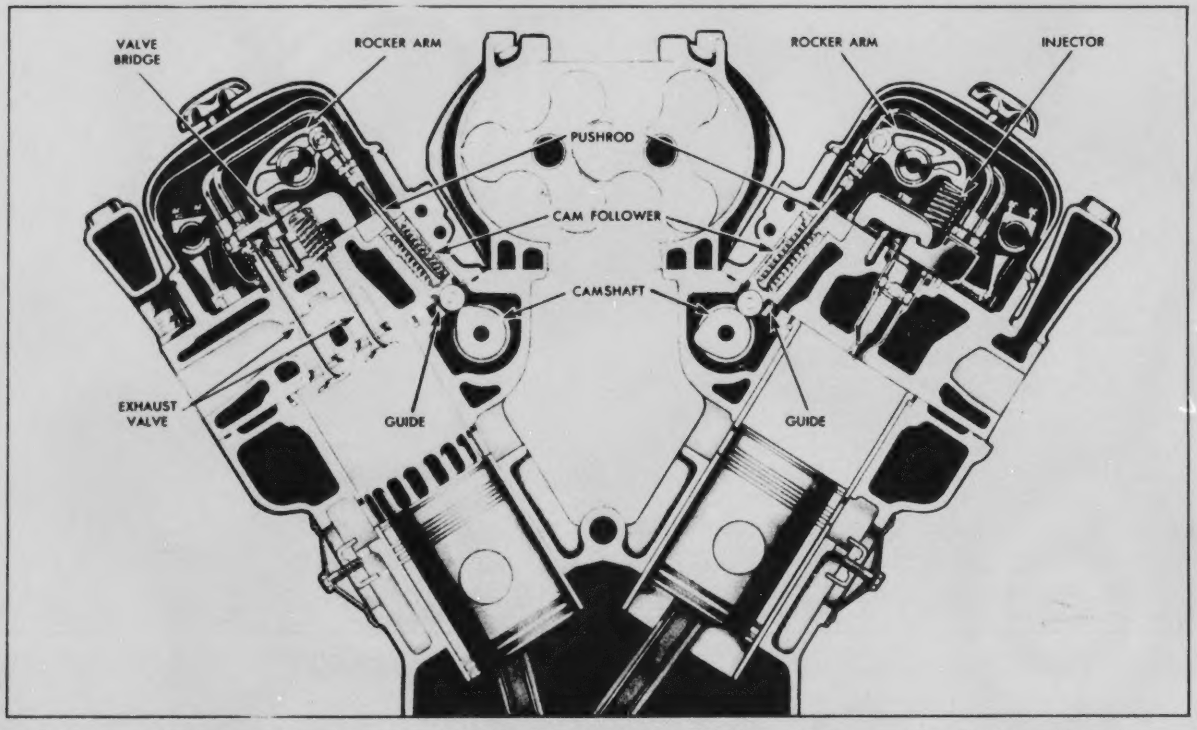


Fig. 8-1. Because the fuel system is more complex than in gasoline engines, diesel fuels must be clean and free-flowing and have the proper octane number.

to take care of ice formation in the fuel tanks. However, if too much alcohol is used, the flash point is lowered, and corrosion on the fuel pump parts is likely. The proper mixture is *1 pint of alcohol to 100 gallons of diesel fuel.*

Premium Diesel Fuels

Many marketers offer a premium grade in the No. 1 and No. 2 fuels. These have additives for increasing the cetane number and are much like the tetraethyl compounds used in gasolines. Higher cetane numbers mean faster starting, faster warmup, and a smoother operating engine.

Premium grades of diesel fuel also have greater detergency or cleaning action and more power to fight rust and corrosion. This quality is very important in increasing the life of the fuel pump, which is the heart of the diesel engine. The fuel pump and injector system must be kept clean and free of any foreign matter that corrodes, fouls, or slows down the high pressure of the fuel flowing through.

Warning!

One of the big disadvantages of having different pumps and grades of motor fuel in one station is that the wrong fuel may be dispensed. *Never put gasoline into a tank designed for diesel—or diesel fuel into a gasoline tank.* As soon as either engine is started, a great deal of mechanical damage has already been done.

It is not uncommon for a customer to drive up to a pump island and say, "Fill it up." The automobile could have a diesel engine under the hood and be sitting in front of a gasoline pump. With so many different types of engines on the road today and with the many different kinds of fuel, it is safer to ask specifically what type of fuel is needed.

Most American-made cars have a warning label next to the tank fill cap that states the exact kind of fuel. However, this is often a decal that may wear off with age. If you are not sure about the type of fuel needed, check first before filling the tank.

Questions

1. What is the major difference between a gasoline engine and a diesel engine?
2. Define the following diesel fuel terms, and explain what they mean: (1) pour point, (2) cloud point, and (3) cetane number.
3. Briefly describe each of the three grades of diesel fuel.
4. What are the main causes of poor performance in a diesel engine?
5. What is the greatest danger in dispensing different fuels at a service station?

Project

From your local refiner or wholesale supplier, get as much information as you can on the blend of diesel fuel for your local region. What additives and compounds are most common? How do these additives improve the quality of the diesel fuel? About what percentage of your fuel sales are diesel fuel?

9

Facts about Motor Oil

Objectives: After completing this assignment, you will be able to—

1. explain why motor oils must keep being improved;
2. explain why today's automobile engines demand a better quality of motor oil;
3. name five things a good motor oil must do;
4. discuss the qualities of a good motor oil; and
5. give valid reasons for recommending oil changes at the proper time.

The Need for Better Motor Oils

As the modern automobile engine goes through technical refinements and changes, so do the lubricating oils. Today's engine is harder working than ever before. As compression ratios go down, and as more pollution controls are added, the moving parts within the engine need better lubrication. The trend is toward smaller, more compact engines that use less fuel and get better mileage. Engine rpms (revolutions per minute) have increased, which means an oil with more stamina and lubricating power under high speed is needed. Also, the cams, valve lifters, and rocker arms have all been beefed up and made stiffer to take care of increased pressure loads—up to 200,000 pounds per square inch! These costly parts will wear quickly with the wrong oil.

Today's engines run much hotter than before. Long trips at sustained speeds on interstate highways put a terrific heat load on the engine. Where boats and trailers are towed for long distances, these heat ranges are even higher. Another reason for higher temperature is the emission control systems that have lean burn carburetion and modified spark advance. The combustion chamber temperature is raised to burn up more of the fuel mixture so that less goes out as air pollution. Many of today's automobiles have additional parts to operate, such as air conditioners, power steering and brake pumps, and automatic transmissions. Each puts additional heat loads on the engine. Only a highly refined and manufactured lubricating oil can stand up to the excessive heat loads.

What a Modern Motor Oil Must Do

First, most of today's automobiles do not work at full capacity. That is, the engine never reaches its maximum horsepower output, and it seldom gets to the proper operating temperature. Most trips are short ones—less than 10 miles. At this short distance, the engine is running "cold." The carburetor is using a rich mixture, which means sooty residue and exhaust. Much of it clogs and fouls the piston rings, and some reaches the crankcase oil. Since the engine seldom reaches proper temperature, the oil remains sluggish, and some parts may not get enough lubrication.

About 80 percent of today's automobile operation is at low speed, for short distances, in stop-and-go service, and in cold weather. This is the kind of service that wears out engines faster than any other. The only solution is a good lubricating oil that stands up to the pressures, strains, and demands of the engine. Also, that oil must be changed at regular intervals.

Provide Easy Starting

A good oil must provide easy starting. Remember, the starter has to do more than just turn the engine crankshaft. The starter is also turning the alternator, fan, air-conditioning compressor, and steering and brake pumps. At low temperatures, the oil has thickened and settled, so starting is much harder. So today's engines demand an oil that remains fluid and flows freely at low temperatures.

Lubricate

The oil must lubricate moving parts. Metal against metal—even the hardest—will wear quickly, and friction would build up so fast that the metal surfaces would melt and stick together. A thin film of oil must adhere to the metal surfaces and prevent metal-to-metal contact. The oil must not thin out at high temperatures. Yet it must be fluid enough to lubricate when the engine is cold.

Protect

One of the unwanted by-products of gasoline combustion is water. No one has yet found a way to prevent condensation action from forming by the vaporizing action of gasoline. When the engine is cold, condensation forms more readily on cylinder walls and in the carburetor. When mixed with the combustible gases, water condensation forms acid. These acids attack the metal parts within the combustion chamber, pistons, rings, valves, and cylinder walls. A modern lubricating oil must offer protection against the corrosive acids. It does this by bonding a thin film of oil to all metal surfaces that are exposed to corrosion.

Clean

An efficient engine is a clean engine. This means no rust, corrosion, sludge, varnish, acids, or other contaminants inside the vital working parts of the engine. A good oil has detergents that keep contaminants in suspension until they are removed by the oil filter. As the oil filter fills up with contaminants, the oil will get saturated and dirty so that it is no longer providing the proper engine care. This is why it is essential to have oil and filter changes at the recommended intervals. Unless changed when needed, the oil is doing more harm than good. And adding clean oil to dirty oil only gives more dirty oil. It is not helping the oil to stay clean.

Seal

Metal parts can only be machined to certain tolerances or clearances. Regardless of how close they are, there is still a space between the parts where acids, water, and blow-by gases can ruin the metal surfaces. Oil must provide a seal to shut out a great portion of these contaminants. This is especially vital between the piston rings and the cylinder walls, and at the valve stems and tips. Oil is also a coolant. By keeping it moving constantly, the oil is helping to take away heat from bearings and other vital parts where the water cannot cool.

Qualities of a Good Motor Oil

A common misconception is that "all motor oils are pretty much alike." No, they are not. And oil that was good enough five years ago will not be good enough for today's engines. Motor oils must keep pace with the changing engineering and technological advances. To do this, advanced motor oils must have certain qualities.

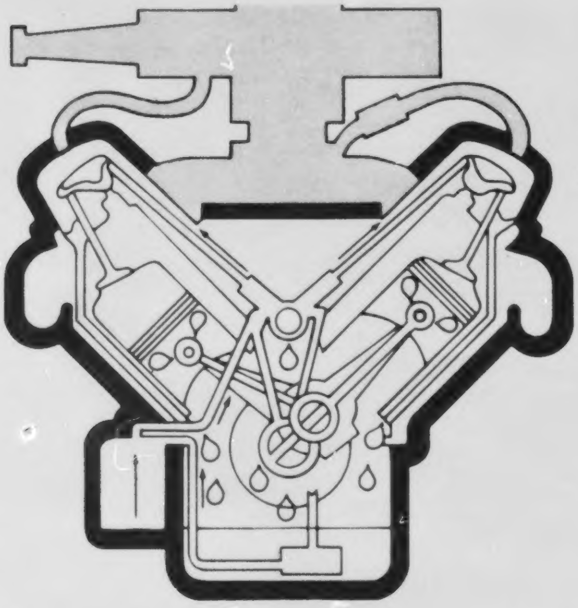


Fig. 9-1. A motor oil must lubricate, protect, clean, seal, and give easy starting.

Combat Temperature Extremes

Heat thins oil, and cold thickens oil. To combat these two extremes, manufacturers have come out with multigrade oils. These are acceptable for most of today's engines and are recommended for newer models. If oil gets too thin, it loses its sealing and lubricating qualities. Cold, thick oil does not flow, and during warmup many parts may not get the proper amount of lubrication. A multiweight oil remains thin and free-flowing at cold temperatures and during engine warmup. As the heat rises, the oil thickens so that it will not thin out and will have good stability on moving parts.

Resist High Pressure

At the tremendous pressures inside an engine, oil will be squeezed from off the surfaces of moving parts. Chemical additives form a tough film of oil on surfaces, so the oil resists pressure. Tough films of oil are critical on the cams, valve lifters, valve stem tips, and rocker arms.

Fight Corrosion

Approximately 1 gallon of water in the form of steam and condensation is formed inside an engine for each gallon of gasoline burned. Water and unburned gases form acid, which attacks all metal surfaces. Continued corrosive attacks is just as damaging as trying to operate without lubrication. Chemical additives in oil fight corrosion by neutralizing the acid so that it does not eat on metal surfaces.

Resist Oxidation

Prolonged highway driving at sustained speeds—especially in hot weather—and towing trailers is harmful to engine life. Oil will begin to oxidize and break down under long periods of high heat and pressure. Oxidation is much like water and acid in that sludge, gum, varnish, and other harmful deposits are made on metal surfaces. A good oil has additives that resist oxidation and formation of gum and sludge deposits.

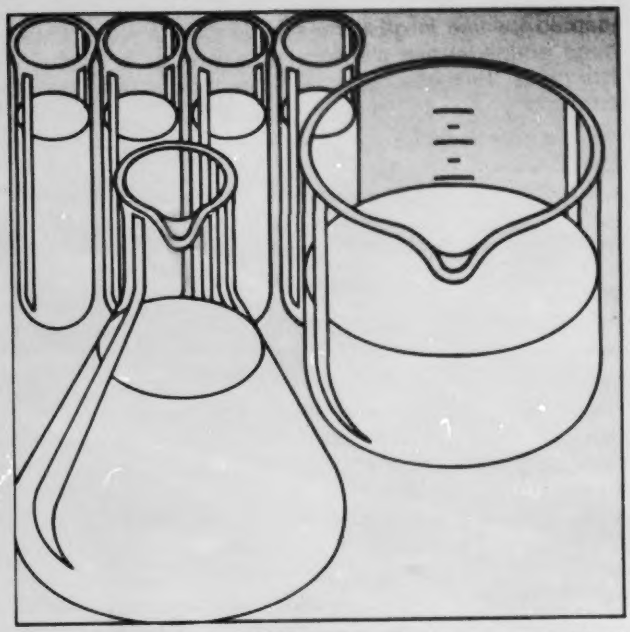


Fig. 9-2. *Chemicals are added to motor oil to increase engine life.*

Act as a Detergent

There is no known way to prevent water, acid, blow-by gases, oxides, and other harmful contaminants from forming inside an engine. These are all the result of the combustion process. So oils are going to collect these contaminants and circulate them throughout the engine. To keep them from harming metal surfaces, a detergent keeps the particles in suspension. This keeps them from massing together to form deposits. A properly operating filter will remove most of the particles as the oil passes through. So the oil can be kept clean much longer and does not have to be changed as often. Most experts will agree that a filter change should be made with each oil change. Otherwise, you have a quart of dirty oil still left in the system, and the filter cannot be as effective as a new one.

Prevent Foaming

Another ingredient that comes from combustion chambers and is present inside the engine is air. At high speeds and pressure, the air mixes with the oil and forms bubbles or foam. Foaming causes oil to lose its lubricating power, particularly on parts under pressure and high heat. A chemical additive prevents the formation of foam so that the oil retains its lubricating power.

Why Change Oil?

This question has been around for a long time. It has been debated in engineering laboratories, in repair shops, on the street, in the news media, and in all types of journals and magazines. Some of your customers will probably ask the same question.

Some contend that oil never breaks down to the point where it stops lubricating and that even "dirty" oil is still a good lubricant. There have also been debates about the superior qualities of re-refined or used oil that has had the dirt and contaminants removed. The debate will perhaps continue.

The problem remains that you must still answer your customer's question by giving sound reasons. Even the best grades and qualities of motor oil have their limitations. *Time* and *mileage* are the two big factors to consider in recommending oil changes. Since there is as yet no way to prevent moisture, acids, and contaminants from polluting the engine oil, in time they will destroy the usefulness of the oil. No matter how good the oil is or what kinds of additives or filters are used, dirt, water, and other contaminants will build up in the oil. Filters are not 100 percent effective. Some contaminants will remain in the oil.

All automobile manufacturers recommend certain oil change intervals. In some cases, the warranty of the

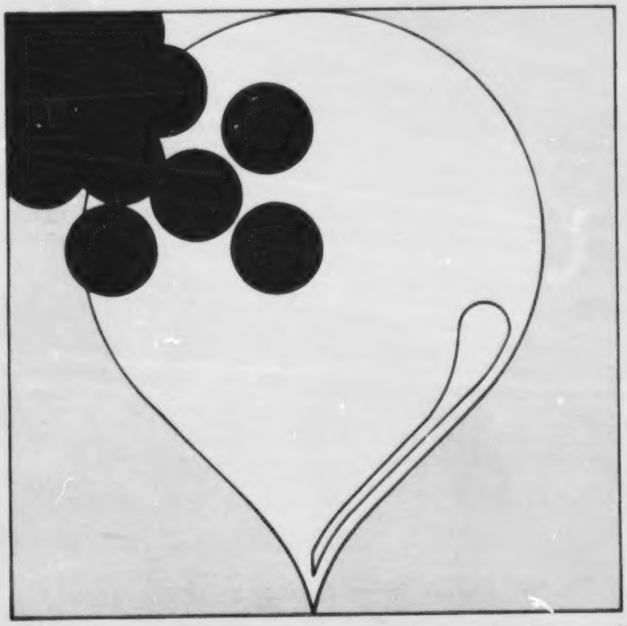


Fig. 9-3. *Oil should be changed because it becomes contaminated and eventually loses its power to lubricate.*

engine and its parts depends on the frequency of oil and filter changes. You should follow the manufacturer's recommended changes. Most will recommend by mileage or time or both. For example, the recommendation may state, "each 5,000 miles or each six months, whichever comes first." Time is as much an enemy of oil as is mileage. Even when an engine is used very little, it builds up contaminants much faster than on long trips and highway driving. Short trips of less than 10 miles each destroy the effectiveness of engine oil within a few months. When an engine is idle and is seldom driven, condensation forms in the crankcase from changes in the outside temperature.

It is to the customer's advantage to make oil changes at the right time. Going a long time without an oil change puts undue wear on the vital parts, and in a short time expensive engine repairs will be required. Making frequent oil changes is good economy and good sense.

Questions

1. What trends in engine design demand new and different motor oils?
2. Why do modern engines run at much higher temperatures than before?
3. Name and briefly explain five things a modern motor oil must do.
4. What is the advantage of multi-grade oils?
5. What is oxidation, and what does it do to motor oil?
6. Why is a detergent necessary in a motor oil?
7. What causes oil to foam?
8. Give valid reasons for recommending oil and filter changes at regular intervals.

Project

Make a chart of the different brands and qualities of motor oil sold by your service station. Begin with the lowest quality first. Give the kinds of service that you would recommend for its use, and its price. Next, list the medium grades, and so on down to the highest quality.

What argument could you use to convince the customer that the better quality oil is the best and most economical buy?

10

Motor Oil Classifications

Objectives: After completing this assignment, you will be able to—

1. explain the importance of viscosity index in a motor oil;
2. explain the service classification system; and
3. recommend the most desirable viscosity grade and classification for a modern gasoline and diesel engine.

Viscosity Classification System

In helping the customer select the right oil, you must first consider the oil viscosity. *Viscosity* means the ability of the oil to remain stable under heat and pressure. A second consideration is the lubrication service required by the engine.

The earliest attempts to classify and identify motor oils began when automobiles were first produced and sold in this country. Viscosity was considered to be the most valuable measure of the quality of an oil—even in the early days when engines were fairly simple. Oils in those early days were simply classified as light, medium, and heavy weights. As engineering became more advanced, instruments were developed that could more accurately measure the viscosity index of oils. The Society of Automotive Engineers (SAE) developed a better system of classification based on viscosity. This has become a fairly standard list of six classifications or grades of motor oil: SAE 5W; 10W; 20W; 30W; 40W; and SAE 50. The "W" stands for *winter* rather than weight as many people think. That means the oil is suitable for use in winter or cold temperatures. To have the "W" classification, the oil must flow freely at temperatures down to 0°F or -18°C. When the numbers appear without the "W," it means the oil has been tested to be used at high temperatures and must remain stable at temperatures up to 210°F or 99°C.

It is important to remember that 20W and 20 are two separate classifications. However, for high-quality oils, the SAE 20 will usually meet the specifications of SAE 20W and vice versa. When it does, the classification is usually listed as SAE 20W-20, for example.

For many of today's engine needs, multiweight or multigrade oils have been manufactured (see table 10.1) These are listed as SAE 5W-20; 5W-30; 5W-40; 10W-30; 10W-40; 10W-50; 20W-40; and 20W-50. The most popular of these are 10W-30 and 10W-40 because they perform well under most temperatures extremes. SAE 10W is light enough to crank easily down to subzero temperatures, and SAE 30W and 40W are heavy enough to stand up under high heat and pressure. A multigrade oil is made by starting with the lightest weight and adding chemical thickeners that change with heat. As the oil heats up, the thickeners change the grade of the oil upward. As temperature drops, the oil thins back to its original weight or grade.

Service Classification System

The automotive and petroleum industries long ago recognized the need for a system by which motor oils could be classified and described. The viscosity classification system was just one step, but it was not enough. In 1947, the American Petroleum Institute (API) established three types of oil: regular, premium, and heavy-duty. However, this was not sufficient for the needs of modern engine perfor-

Table 10.1
Guide to SAE Grades

Lowest Expected Temperature	*Single Grade*	*Multigrades*
32°F (0°C)	20, 20W, 30	10W-30, 10W-40, 10W-50, 20W-40, 20W-50
0°F (−18°C) down	10W	10W-30, 10W-40
to below 0°F	5W*	5W-20,* 5W-30, 5W-40

*SAE 5W and 5W-20 are never recommended for sustained high-speed driving.

mance. The API and the American Society for Testing and Materials (ASTM), along with the SAE, cooperated to come up with a new Engine Service Classification System. This system enables engine oils to be defined and selected on the basis of their performance characteristics and the type of service for which they are intended. It should be remembered that there is no relation between service classification and viscosity classification.

Table 10.2
API Engine Service Classification System

Service Classifications	Related Uses
SA	Straight mineral oil
SB	Inhibited oil
SC	1964 warranty approved
SD	1968 warranty approved
SE	1972 warranty approved
SF	Supersedes all other classifications

The five classes of service are shown in table 10.2. The letters and explanations of use are as follows: The letter S means "service" as in service stations, garages, and new car dealers. The A, B, C, D, and E classes mean the intended uses for specific models of new automobiles and trucks.

SA—utility gasoline and diesel engine service. This oil is acceptable for engines operating under mild conditions where protection of compounded oils is not needed.

SB—minimum-duty gasoline engine service. This is for gasoline engines operated under mild conditions and where only a minimum amount of protection is needed. Primarily, the only protection provided is antiscuffing of metal parts, antioxidation, and bearing corrosion.

SC—for 1964 gasoline engine warranty up to 1967 models. Oils for these engines require antioxidation at high and low temperatures, wear, rust, and corrosion control.

SD—for 1968 gasoline engine warranty up to 1970-72 models. Oils in this service must provide more protection than in any of the previous classifications.

SE—for 1972 and later models of engines. Oils for these automobile engines must provide maximum protection against oxidation, rust, corrosion, and must last longer under service than any of the previous classifications.

SF—The newest classification meets or exceeds the requirements of all manufacturers' engine specifications for 1975 models and later.

For commercial uses, the letter C is substituted for the letter S. These oils are for large trucks, for contractors, and for farmers and others who use larger engines in other than highway and road services. For these customers, the classifications are as follows:

CA—service typical of diesel engines operating under mild conditions in moderate duty and with high-quality fuels. Protection against corrosion and ring deposits is given by this class.

CB—service typical of diesel engines in mild to moderate operations, but using a low-quality fuel. This oil gives more protection against bearing and ring corrosion, deposits, and where sulfur-saturated fuels leave a high level of contaminants in the engine.

CC—service for diesel engines that are turbocharged or supercharged, operating moderate to severe service. It is also used in large, heavy-duty gasoline engines. Protection against oxidation, rust, corrosion, sludge, and other harmful deposits must be provided by this classification.

CD—for turbocharged and supercharged diesel engines in all types of service and duty requirements, where all qualities of fuel may be used. This oil must provide maximum protection against bearing corrosion, rust, oxida-

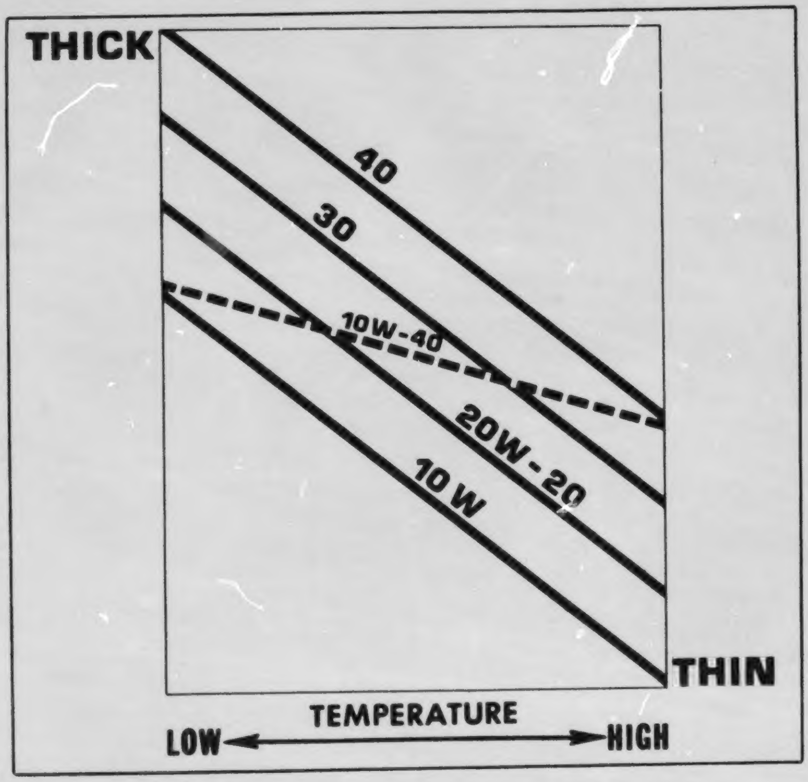


Fig. 10-1. How a multigrade oil works (Courtesy American Petroleum Institute)

tion, temperature extremes, and other contaminating conditions.

Some oil manufacturers put out multiclassifications. This means that one oil meets all the specifications for both gasoline and diesel engine services, and operation under heavy to extreme temperature conditions. Such an oil would carry the classification "API Service SF-CC."

What Are Sequence Tests?

Reference is sometimes made to "sequence tests," "ASTM sequence tests," or "car manufacturer's sequence tests." All mean the same thing. With today's advanced engineering technology and high-performance engines, oils cannot be measured by physical and chemical tests alone. Engines are tested in the laboratory and on the road. The ultimate test for performance of a motor oil is how it stands up under actual operating conditions. However, field testing takes a long time and is quite expensive.

To compensate for the time and expense, and yet get an accurate measure of performance, engineers have devised a "sequence test." The engines used are of the same designs found in today's automobiles and trucks. Hundreds of hours of testing oil in car engines under changing conditions of load, speed, and temperature extremes are involved. The exact performance of an oil can be measured under any kind of test desired. Even this type of testing is expensive, but it is not as time-consuming as the road-test method. To validate a laboratory test, these oils are put into taxicab fleets, police cars, and all kinds of service vehicles. Data from these tests are compared with those from the laboratory. It has been found that sequence testing is very accurate.

In summary, if a motor oil has a service classification of "SE," it can be safely recommended for any use in a gasoline engine. This means that the oil has been tested and validated under all kinds of tests and can meet or exceed all requirements of the car manufacturer. For diesel engines, an oil classified as "CD" can be safely recommended as meeting or exceeding the manufacturer's requirements.

But remember that service classification alone is not enough. You must also select the proper viscosity index. Remember, also, that no oil will hold up forever. It must be changed at regular intervals to provide maximum lubrication and protection.

Questions

1. Briefly explain the viscosity classification system.
2. What are multiweight oils?
3. Why are the 10W-30 and 10W-40 oils the most popular?
4. What is the service classification system?
5. What is the major difference between a service classification with the letter S and the letter C?
6. What one service classification would be the safest to recommend for any type of gasoline or diesel engine under almost any operating conditions?

Projects

1. Select a can of motor oil at your training station. Write down all the letters and numbers that are stamped into the can top. Now, explain what each of these means and how the can top is read. If in doubt, ask your training sponsor.

2. Answer the questions in the following situations:

   Situation 1: A customer drives in with an older model car that is smoking badly and obviously is in poor mechanical condition. The customer asks for a quart of oil, stating that he must put one in every 100 or so miles. What grade, weight, and classification would you offer?

   Situation 2: A customer drives in with a new automobile with a diesel engine. She wants an oil change, but does not know what weight, grade, or classification of oil is needed. The odometer shows 7,100 miles. What motor oil grade and classification would you recommend? Where would you find the information you need for that particular make and model?

   Situation 3: The customer is a "regular." She drives every day but only makes short trips—usually about 5 to 6 miles at a time. The car spends as much time in the garage as on the street. It is seldom driven on the highway. What grade, weight, and classification of oil would you recommend? How often would you recommend an oil change? Why?

Objectives: After completing this assignment, you will be able to—

1. explain why motor oil needs to be sold rather than left to impulse buying;
2. tell why attitude and confidence are so important in selling motor oil;
3. tell how to find out if the oil needs changing; and
4. explain ways to recommend an oil change.

11

How to Sell Motor Oil

Before you can sell motor oil, three things are essential:

1. You must have adequate stocks of motor oil.
2. Motor oil stocks should be on display, accessible to the customer.
3. You must know enough about motor oil in order to sell with confidence.

It is unfortunate that too many retailers of motor oil have taken a "self-service" approach. Motor oil does not sell itself. Customers should not be left to decide which oil they need, nor when they need it. To begin with, most customers do not know exactly which oil their car needs. Also, most customers seldom think about when their car needs an oil change. Unless prompted and reminded, they tend to put it off, and their automobile is being damaged as a result.

Selling Requires a Right Attitude

The first stations were called "filling stations." The vintage automobile pulled up to the pump because it usually needed gasoline, perhaps a quart of oil, and nearly always water in the radiator. Besides taking care of those needs, it was always a good idea to add air to the tires.

Later, they became known as "service station," because all kinds of services were sold to the customer as well as many auto-related products. It was service that attracted and held customers. The more service and the better services provided, the more customers.

In recent times, most "service stations" have moved toward *self-service* merchandising. The reasons are many. Labor became more expensive, and self-service cut down on labor. Newer models of automobiles required less servicing—longer periods between oil changes, fewer parts to lubricate, and less maintenance work. Self-service is also popular because it is price competitive.

What has all this led to in petroleum products retailing? It has left the customer to take care of his or her own automobile. And the truth is, too few customers are taking care of an expensive investment. All this proves a point about personal selling. Self-service may be a method of merchandising that cuts down on costs and expenses, but it does not serve the consumer. People still need to be "sold" products and services. When consumers are left to decide for themselves, needed products and services are usually forgotten or put off too long. You can't ignore an automobile or motor vehicle and expect it to perform satisfactorily. If needed services are put off too long, this usually means expensive repairs and needless inconvenience.

Selling always has been and always will be a matter of right attitude. What is a right attitude? It means that you believe that you have a product that the customer both needs and wants. People still need to be sold on products that are necessary for their lifestyle and well-being. In modern America, the automobile is no longer a luxury. For most people, it is a necessity for basic transportation. Even with inflation and spiraling prices, even with energy shortages and the need for conservation, most people still depend on the automobile for transportation. As long as this is true, people need basic products to maintain those automobiles and keep them operating. There is no more basic product than motor oil.

Selling Requires Confidence

The surest way to win and hold customers is to sell good products with confidence. Confidence comes from knowing your product and being able to recommend the right product. If you know your product, what it will do, when it is needed, and how it assists in the overall maintenance and operation of a basic necessity, then you can sell to anyone—with confidence. Confidence gives you self-assurance in knowing what is best for the customer.

Confidence helps you make the approach, determine needs, answer questions, handle objections, and close the sale satisfactorily. If you know your product and what it will do, then you can feel good about your job of selling. It is when you don't know, have doubts, or lack information, that you begin to dislike selling. Assignments 9 and 10 presented the technical information on motor oils, what they do, and their performance characteristics. This assignment tells why you should sell and how to do it.

Who Are Your Customers?

Every individual who owns, leases, rents, or drives an automobile needs motor oil. Every person who enters your place of business is a potential customer. All motor oil must be changed at one time or another. So, even though an oil change may not be needed today, it will within a short time. And motor oil can be bought any time, even though it is not needed immediately. So there is no reason to hesitate to sell motor oil to almost every customer. There is no shortage of customers, and you are selling a consumable product.

Today's Prospects

Even in a self-service outlet, you can still approach a customer and ask about an oil change. Often, the self-service customer comes in only to "gas up." Few check under the hood. The reason is simple. It's hard to reach in under the hood and take out the oil dipstick without getting your hands or clothing dirty. Since most people are in a hurry and won't take the time to wash up afterwards, this area is left alone.

You are performing a valuable service whenever you ask any driver about an oil change. Ask when the last change was made. If the customer is unsure (and most of them are), ask to check the front door panel. Most oil changes are recorded on a narrow strip of paper attached to the left front door end panel or on the door post. Other places to check are the top of the air cleaner element or the front cross-member support around the radiator.

The best indicator of need is not mileage alone, but time between changes. If it's been over six months, the oil probably needs changing because of moisture and contaminants that dilute the oil. Other conditions that call for frequent oil changes are extreme heat or cold and in-town, start-and-stop driving. Also, if the oil on the dipstick is very dirty or black, you can be sure that a change is needed.

An oil change takes only a short time to do. Never hesitate to ask the customer if you can change the oil now. If not, then make an appointment, but urge the customer not to wait any longer than possible. Even though the automobile manufacturer makes specific recommendations about oil changes in the owner's manual, most customers regard these only as *recommendations*—not as necessities.

In mass merchandising, self-service stores, oils are stocked in a mass display. However, there is seldom enough information at the display to help the customer know what type, weight, or classification is needed. Most customers select the oil by brand name or price and rarely pay attention to other important factors.

Customers will buy motor oil and have it changed if they are given good sound reasons for doing so. Here are four ways to recommend an oil change.

1. Suggest a change today if the date, mileage, or appearance of the oil seems to indicate one is needed. Suggest a needed oil change when entering a new season, such as fall, winter, spring, or summer. Suggest a motor oil purchase for a change needed later on.

2. Even though the customer is in a hurry and cannot take the time now, make an appointment for a change in the next few days. Give reasons for changing. Tell the customer what happens to the engine when the oil gets dirty, diluted with moisture, or filled with contaminants. Tell how inexpensive an oil change is as compared to the cost of a ring and valve

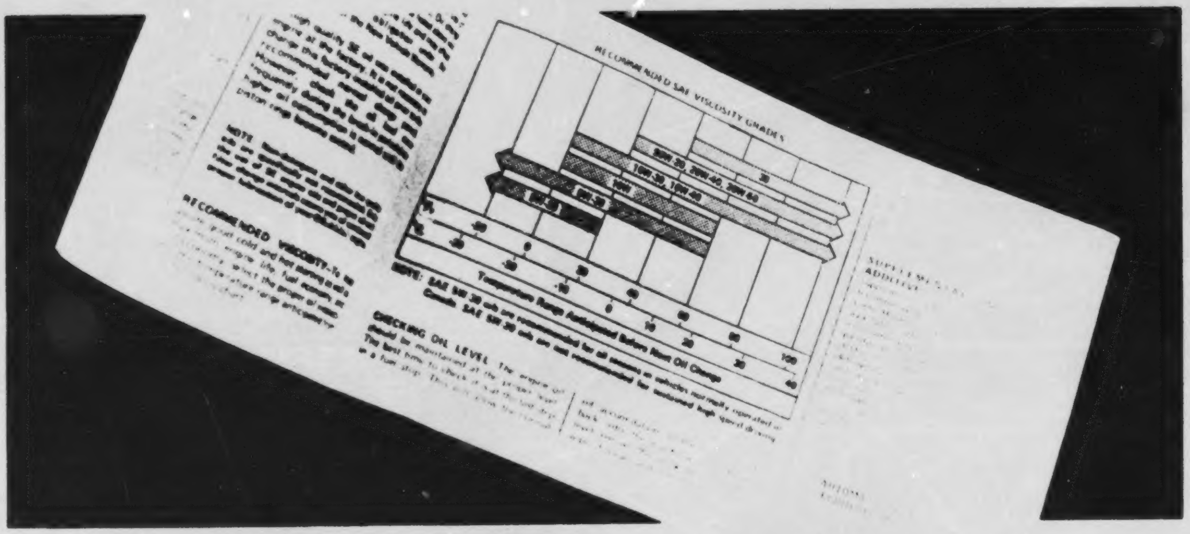


Fig. 11-1. The owner's guide is a good selling tool on motor oil and regular oil changes. (Courtesy American Petroleum Institute)

repair and replacement. If you make an appointment, follow up on it. Call the customer the day before, and remind him or her of the time. Your taking the time to call will usually win you a loyal customer. People appreciate care and service.

3. For the customer who is looking at a motor oil display, ask a direct question, "Have you checked your car's oil lately? It may need a change." Ask if you may check the dipstick or the sticker on the door panel. If the customer is not certain how often the oil should be changed, ask to check the owner's manual, usually in the glove compartment.

4. For the do-it-yourselfer, suggest oil today for a later need. Special prices, sale events, season changes, and vacation travel are all good times and reasons to suggest a motor oil purchase.

Tomorrow's Prospects

Even if the customer doesn't need a change today, one will be needed within a few weeks. Suggest that the customer allow you to make it. Make an appointment, and start a card file on the customer. A good theme to sell everyday is, "Let us take care of your car for you." While a few people do their own motor oil changes and enjoy working on their cars, most would rather let someone else do it. With today's cars, unless a person has the proper equipment, it is hard to crawl underneath to make the change.

Determine the approximate date of a needed oil change. Then take the customer's name, address, and telephone number, and enter it on a card. Put it in a date file. Then, just a few days before that time, call the customer and remind him or her of the oil change. Set a time and ask the customer to come in. Most oil and filter changes require only twenty minutes. A complete oil change, filter change, and lubrication can be done in about thirty minutes. If you make an appointment, then follow through and call ahead of time. Enter the date and type of oil on the customer's card. Determine the next approximate change date and call again. This will win you a loyal, faithful customer.

How about the customer who buys oil somewhere else but wants you to change it? You should follow your company policy, but where there is none, you can do this. Go ahead and change the oil for the customer, after first reminding him or her of the service charge. Take the opportunity to recommend your own oil and service available. Remind the customer that your oil is of the best quality, and that after paying the service fee, he or she did not really save that much on the "bargain" oil. Sell service along with your quality products. Try to win the person as your regular customer for all types of needed products and services.

Sales Strategy

Most beginning salespeople are reluctant to approach customers and ask them to buy. The reasons for this are several. Many hesitate because they don't know exactly what to say. Others are not sure about the customer reaction. Most people hate to be rebuffed or turned down, so they never ask. Some people have a basic shyness that overcomes their desire to sell. To combat these natural feelings, you should recognize two facts. (1) You can talk about your product if you know enough about it. (2) Every customer in your place of business is there to buy something. Just merge these two facts, and you have the strategy for selling.

What to Say

Good sales openers or approaches are these:

- "When was the last time you changed your motor oil?"
- "This is the finest quality of oil you can put in your engine."
- "This is really an exceptional sale price—better stock up now for your next oil change."
- "How often does the manufacturer recommend that you change the oil?" (Most will not know; ask to check the owner's manual.)
- "Your car is an expensive investment. Just a few dollars for an oil change will help protect it for a long time."
- "You ought to let me check your oil and get your car ready for summer (winter) driving."
- "It's much cheaper to change oil too soon than to let it go too long."

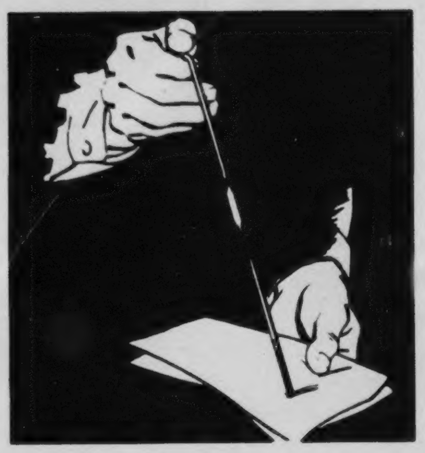


Fig. 11-2. Show the motorist the oil dipstick.

What to Recommend

Suppose the customer is interested in the motor oil display. The customer may say, "Okay, let me have five quarts." What kind? What weight? What service classification? Take time to ask some questions to help you recommend the right oil. Four kinds of information are essential: (1) the year model of the car; (2) the type of engine; (3) the date of the last oil change, or approximate mileage; and (4) the kind of driving the customer does.

The *year model of the car* is important. Older model cars or ones with excessive mileage can get by on a classification less than *SE*. However, *SE* is always a safe suggestion for any make or model. Newer models must have it. You never go wrong in recommending the best-quality oil for most cars. You wouldn't recommend it for those that are using excessive amounts between changes or for very old models with 100,000 miles or more.

The *type of engine* is important. All gasoline engines require an oil with a service classification, *SC, SD, SE,* or *SF.* All diesel engines require a service classification of *CC* or *CD.* If the customer does not know and you have doubts, ask to check the engine or the owner's manual. It is also important to remember that diesel engines require more frequent oil changes than do most gasoline engines.

Time and mileage are the best indicators of needed oil changes. The owner's operating manual gives the manufacturer's requirements for both. The manual states the intervals between oil changes in terms of miles driven and the amount of elapsed time the oil has been in use, regardless of mileage.

Ask what *kind of driving* is done most. Short-trip driving, which makes up the largest percentage of total miles for most people, is hard on motor oils. Even the best-quality oils become diluted and contaminated with this kind of driving. Driving at high speeds on long trips and in hot weather conditions makes oil break down. Multiweight oils are best for general driving conditions because they adjust to temperature changes and give the best weight and lubricating ability at the widest ranges of needs.

When to Recommend

Make the assumption that today is as good as any time to sell motor oil. It does not have to be put in the engine today. Oil has a long storage life as long as the container is unopened. Some customers will need an oil change today—some within a few days or few weeks. But oil is always needed and can be recommended without hesitation.

Sell Service

In addition to motor oil, you are selling service. Let customers know you are interested in their needs and in keeping their car in top condition. Regular oil changes and lubrication are absolutely essential to good mechanical condition and top performance. Recommend all the other services your company offers. Tell the customer about them. Ask for their regular business. Let motor oil be only an introduction to total car care.

Sell Related Products

Don't stop with selling only motor oil. Every oil change should have a change of oil filter as well. Here is the most valid reason. Filters wear out by becoming clogged with contaminants and sludge. A filter will only absorb so much. When the filter's efficiency is reduced, it doesn't make much sense to put in 5 quarts of clean oil that will be circulated through a dirty filter. Besides, about a pint of oil always remains inside a filter housing. This is dirty oil that will be mixed with clean oil just as soon as the engine starts.

For the do-it-yourselfer, suggest an oil change pan, filter wrench, filter, and pour spout. Many engines require the use of a large-capacity funnel to help with oil refills. Don't forget oil for the automatic transmission, top lube oils to add to the gas (especially helpful for engines that use unleaded gas), and air and gasoline filters. More information will be given on these products in later assignments.

A Final Reminder

Every product mentioned in this assignment is absolutely essential to the efficient operation and maintenance of the automobile. You are not asking the customer to buy frills or fad merchandise. You are not selling luxuries or suggesting items that can be done without. You are selling service, and you are doing the customer a favor by calling his or her attention to a real need.

Questions

1. Briefly explain why motor oil must be sold.
2. What is the right attitude you should have toward selling motor oil?
3. What part does confidence play in selling motor oil?
4. Who are your potential customers for motor oil?
5. What are some methods you can use to find out if the oil needs changing?
6. What is the best indicator that an oil change is needed?
7. Name four ways to recommend an oil change.
8. What two facts give you the strategy for selling motor oil?

Projects

Choose one of these.

1. From your company's own private brand of motor oil, or from any nationally advertised brand, construct a plan for selling, as follows:
   a. Prepare two statements or facts about the oil that you can use when you approach a customer looking at a display of the motor oil.
   b. Prepare two questions you can ask of the customer to determine his or her need for an oil change.
   c. Prepare a customer information card that will serve as a date reminder for oil changes. Allow space for such things as year model and make of car, kind of oil and weight needed, dates of oil changes, kind of driving done, and other important information. Make the card fit the kind of business where you are presently working or training.
2. Prepare a sign card about 11 by 14 inches that would go on a mass display of motor oil. Select a brand of oil. Use catalogs, brochures, or selling literature for illustrations. Give a reason for buying the oil today. Prepare sales copy that gives at least three essential points about the oil. Give a price that is reasonable. Suggest additional services (if they are offered by your training station).

12

Replacement Filters

Objectives: After completing this assignment, you will be able to—

1. describe the two major types of oil filter systems and how each is serviced;
2. name three reasons for changing the oil filter;
3. describe the purpose of air filters and how they are serviced;
4. tell what precaution is necessary when installing a new fuel filter; and
5. give two good selling points on buying replacement filters.

Three major kinds of filters need service or replacement on an automobile—oil filters, air filters, and fuel filters. Oil filters are replaced most often. The other two require periodic inspection and replacement, depending on the condition of the filter. In addition, the PCV (positive crankcase ventilation) system has filters. These should be inspected periodically and replaced if needed.

Oil Filters

The purpose of the oil filter is to remove as much dirt, moisture, and contaminants from the oil as possible. Filters have changed over the years so that they are greatly improved, last longer, and do a much better job than previously. Oil filtering systems are of two types—bypass and full-flow.

Bypass System

On older model cars and trucks, fleet cars, taxis, and some police units, a bypass system is used. You will also find it on some import models. The filter is most often attached to the side of the engine block or manifold. The reserve oil passes through the filter, and eventually the entire oil capacity is filtered. However, it is not continuously filtered. The filter is easily reached and replaced. The housing is left intact and only the filter element is disposed of.

Full-Flow System

In this system, the oil is filtered each time the oil circulates. It is more efficient and does a better overall job of keeping the oil clean. The filter element is sealed inside the housing and screws onto the side of the engine block—usually on the lower front side.

The filter and housing are a single unit and are both disposed of. The two major problems with changing these filters are (1) using the wrong size filter, which will leak, and (2) failing to get a good seal with the gasket.

The Filter Element

Most modern filters are made of a special paper that is coated to prevent oil soaking. The paper is pleated so that the filtering surface is greatly increased. Microscopic-sized holes trap much of the dirt, foreign matter, and sludge. If the filter is used long enough, the holes fill completely and will no longer let the oil pass through. A relief valve opens and lets the oil pass through into the system so that the engine does not lose its lubrication.

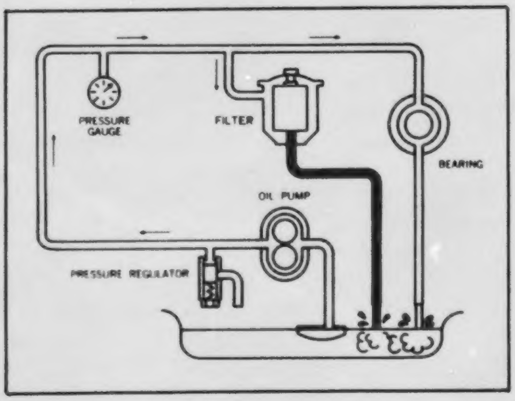


Fig. 12-1. In the bypass system, only the reserve oil is filtered.

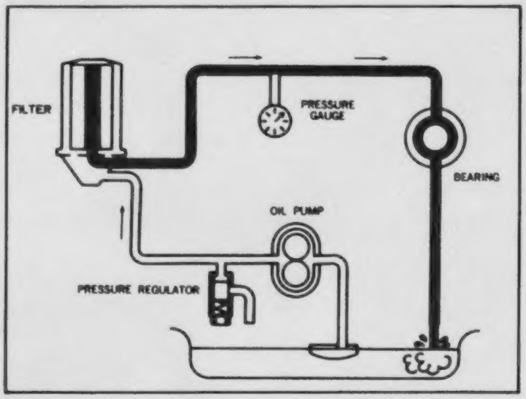


Fig. 12-2. In the full flow system, all of the oil is filtered with each complete circulation.

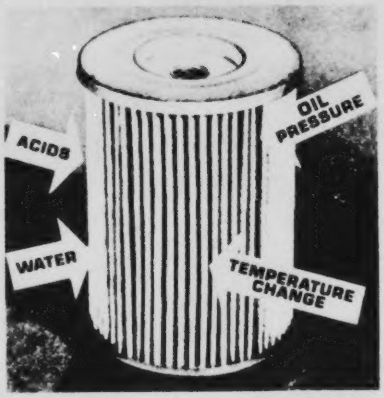


Fig. 12-3. Pleated paper must be treated to resist water, acids, pressure, and high temperatures.

However, the oil is not being cleaned, and the diluted oil is not doing its job. Engine wear is greatly increased.

Some lesser-quality filter elements use a combination of cotton and wool waste fibers, wood fibers, and similar products. While these will remove some of the contaminants, they are not as effective. Also, the filter is used up in less time. As long as the customer is buying a filter, it costs only a little more to buy the best quality. The saving in engine wear and replacement parts far exceeds the cost of the filter.

Why Change Filters?

You change filters for the same reason you change oil. Filters wear out. There are three good reasons to give your customer on replacing the oil filter each time the oil is changed—even though the owner's manual may not be that specific.

Reason 1: If you change oil but not the filter, you are circulating dirty oil inside your engine. The filter housing retains about 1 pint of oil. When you put clean oil in the crankcase and start the engine, the dirty oil mixes with the clean, new oil.

Reason 2: A filter only lasts so long. When it gets clogged with dirt and sludge, the dirty oil continues to circulate. An oil filter is only effective for about 4,000 to 5,000 miles. Under extremely dirty or dusty conditions, or in sandy areas, the filter should be changed more often.

Reason 3: Oil filters are fairly inexpensive. For only a few dollars more, you have the assurance that your engine will have clean lubricating oil and damage will be greatly reduced.

Changing the Filter

In the **bypass system,** first loosen and remove the bolt holding the lid. Remove and throw away the filter element. Use a rag to wipe out the remaining oil and sludge from the filter housing. Some solvent on the rag will finish the cleaning. Do not pour solvent into the housing. It will run down into the engine, dilute the remaining oil, and wash dirt and sludge into the lubricating passages.

Replace the filter element. Inspect the gasket seal on the housing lid. If it is old, cracked, compressed, or appears worn and warped, replace it. Put a small amount of engine oil on the gasket seal surface to improve the sealing action when the lid is tightened. Start the engine, and check for leaks.

In the **full-flow system,** the filter element and housing are a single sealed unit. Loosen the filter with a strap wrench. Firm pressure will usually make the unit turn slightly. Do not hit or bend the filter canister in order to loosen it. You may damage the threaded base part that holds the filter. Do not remove the filter until you have an oil waste pan underneath it. Otherwise the oil trapped inside will spill. Make sure that you replace the filter before you pour the new oil into the crankcase.

It is critical that you check the filter for proper size. Don't test by visual size or appearances. Two filters may look almost identical and yet not be the same. Check the numbers and look in your guide book to make sure the make, model, and engine size are the same.

It is also critical that you *check the old gasket* and see that it is completely removed from the engine block base. If only a small part remains, it will keep the new filter from sealing properly. Use a putty knife or similar scraping tool to remove dirt, sludge, and old gasket material. Wipe clean with a rag and solvent. Check the new gasket, and make sure it is free of warps and is seated properly. A small amount of engine oil on the gasket surface will help it seal. Spin on the new filter, and *hand-tighten only.* Do not use the strap wrench. Engine heat will pull the new filter down to proper tension. Forcing a new filter when it is cold will likely damage the lip and cause it to leak.

Start the engine, and check for leaks. Also check the oil pressure gauge or oil pressure light. Make sure the oil pressure system is working properly. Shut off the engine, and check the dipstick. It should be *at* the full mark—not over the full mark. If it is, drain some of the oil from the crankcase. Excess oil in an engine will be thrown out, creating unnecessary oil leakage.

Air Filters

In a gasoline engine, the air-fuel ratio is about 15:1. For every drop of gasoline burned, fifteen times that volume of air must be drawn through the carburetor to vaporize the gasoline. An air filter is vital to the life of the engine. Air is full of dust, sand particles, and other foreign matter. Even though these are so small the human eye can barely see them, their presence inside an engine would soon wear away the vital parts. To clean the air before it enters the carburetor, a filtering device is necessary. The two basic types are (1) an oil bath or wet filter and (2) a paper element dry filter. Oil-bath filters are found only on older model cars. These need only cleaning and a change of oil. Paper element dry filters are disposable.

Filtering Elements

The *paper element* is perhaps the most common type used today. The element itself is round to fit inside the air cleaner housing. The paper is specially treated to resist moisture and swelling. It is pleated so that the filtering surface is greatly increased. Molded plastic forms a top and bottom ring over and under the paper element. When the top of the filter housing is tightened, an airtight seal is formed. Very fine holes or pores allow air to pass through the paper, but larger dust and dirt particles are trapped.

To service the paper air filter, unscrew the wing nut on top of the filter housing, and remove the lid. On many models, PCV hoses are attached to the filter housing, and these must be removed first. Lift out the filter element, and inspect it carefully. One method is to place it over a light bulb and see how much light shows through the paper filter. If it is badly clogged, replace the filter. If there is good light, then tap the element gently several times on a flat, hard surface to loosen the dirt. Then use a high-pressure air gun to clean by blowing from the inside toward the outer surface. Replace the filter inside the housing, and then the lid. Tighten the wing nut, and reattach the PCV hoses. Make sure you don't screw the wing nut too tight as it might cause a distortion of the carburetor and affect the butterfly valve.

Another popular filtering element is *polyurethane foam*. The foam acts in much the same way as the pleated paper, allowing air to pass but trapping dust and dirt. The foam is stretched over a wire mesh support ring. To improve the dirt-trapping ability of filters, a light oil coating is used. Polyurethane can be removed, washed in warm soapy water, rinsed, squeezed dry, and replaced.

Some filters have the paper element with a polyurethane foam ring outside. This gives a double-acting filtering action and lasts longer.

The older *oil-bath filter* needs occasional cleaning and servicing. In this type, a metal housing has an oil reservoir with a wire screen that supports a cotton filtering element. As the air is drawn in, it is forced over the oil which removes the larger particles of dust and dirt. The force of the air makes a fine oil spray that saturates the cotton filter. The air then goes through the filter where the finer dust and dirt particles are removed before it enters the carburetor. The oil spray runs back into the reservoir, carrying the dust and dirt with it.

Even though this is a permanent type of filter, it does require periodic cleaning and refilling of the oil reservoir. Remove the air cleaner housing. Handle carefully so that the oil does not spill into the carburetor opening. Remove the wing nut, and lift out the filtering element. Wash the wire mesh and cotton filter in a solvent, and dry with a compressed air gun, blowing from the inside toward the outer surface. Pour out the old oil in the reservoir, wipe clean with a solvent-soaked rag, and refill with new oil to the top of the fill mark. Do not overfill. Oil above the fill level will run into the carburetor and stall the engine. Use a 40W oil or heavier.

Fuel Filters

Fuel filters remove dirt, rust, water, sediments, and other foreign particles from gasoline. Even a new automobile begins forming condensation and rust in the tank, so a filter system is necessary for smooth, efficient running of the engine. Fuel filters may be in several different locations, and some cars have more than one filter in the system. The owner's manual for each automobile recommends how often fuel filters should be inspected and replaced.

Caution: When a fuel line is disconnected, some gasoline always runs from the opening. *Use extreme caution when disconnecting the fuel line* to replace the filtering element. Gasoline on a hot engine will likely cause a fire.

In-line Type

The most common type of filtering element is the in-line style. It is usually located between the fuel pump and the carburetor. These filters are sealed elements inside a metal or plastic housing and are disposable. The filter is secured to the fuel line by clamps, either spring wire or screw type. On some models, the filter housing has a vapor bypass nipple with a second hose to the pump. Remove the entire assembly, and replace it with the correct model number. Look at the direction flow arrow, and install the new filter in its right direction. The arrow points toward the carburetor and away from the fuel pump.

Inlet Type

On some models, the filter is in the inlet passage of the carburetor housing. Many are made from porous bronze molded into a hollow cylinder

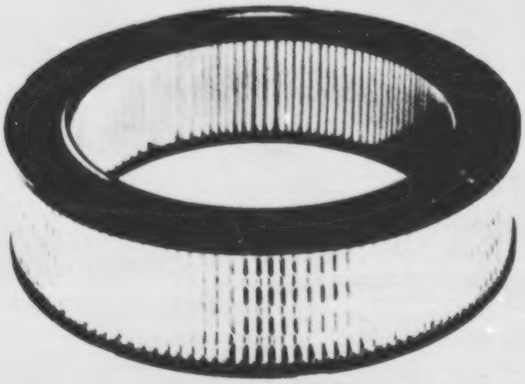


Fig. 12-4. The pleated paper dry element is the most efficient air filter.

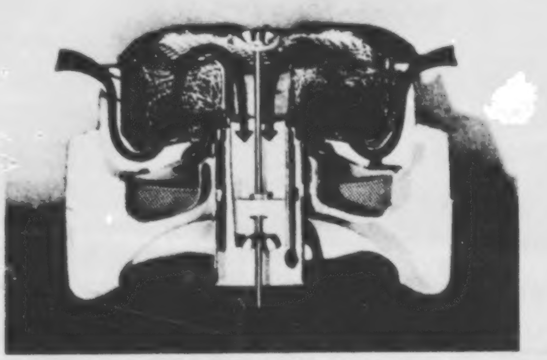


Fig. 12-5. The older oil-bath filter uses an oil reservoir to trap dirt.

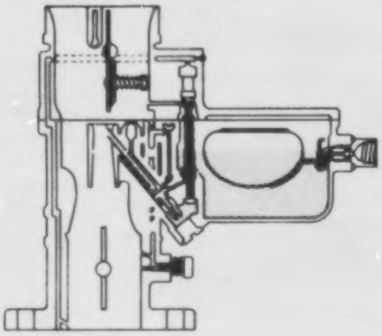


Fig. 12-6. Fuel filters keep contaminants from fouling the close tolerances of the carburetor.

shape. To remove the filtering element, you must remove the fuel line inlet from the carburetor. Two wrenches must be used—one to hold the hex nut in place while the second unscrews the fuel line nut. Use caution so that neither nut is damaged or forced. A tight seat is absolutely necessary to prevent fuel leakage.

Remove the inner filter, gaskets, and spring. Note the order in which the three are installed, and reassemble in the same order. Make sure the new filter element is correctly installed with the right direction pointing toward the carburetor inlet. Retighten the fuel line nuts. Do not overtighten. Start the engine, and check the seal carefully to make sure no gasoline is leaking from it. Use the end of your finger to feel rather than observation.

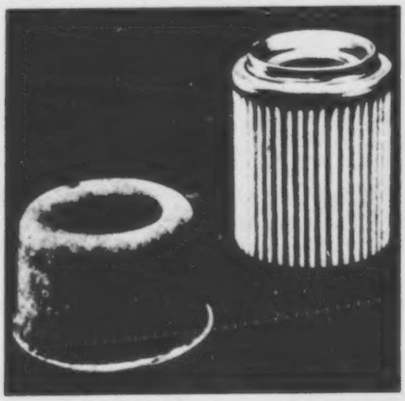


Fig. 12-7. Fuel filter elements are either pleated paper or a porous ceramic or metal.

Fuel Pump Outlet Type

Some models of Cadillac and Chrysler cars have a fuel filter mounted inside the fuel pump at the outlet fitting. First, put a clamp on the inlet hose in front of the fuel pump. This will prevent gasoline from siphoning back toward the tank. Unscrew the outlet hose from the pump, and remove the disposable filter element. Replace with a new filter, and reseat the outlet hose connections. If the filter element is enclosed by a nylon mesh screen, do not clean the screen. After tightening the connections, run the engine and check for leaks at the connection. Make sure you have removed the clamp from the inlet side before starting the engine.

Disposable Element Types

Some model cars have a disposable element canister on the bottom side of the fuel pump. It looks like an oil filter canister. Older model Ford V-8 engines have this type. Some Cadillac models have a similar type between the pump and carburetor. Unscrew the old filter, and replace it with a new canister. Start the engine and check for leaks.

Sediment Bowl Type

Many older model automobiles used a sediment bowl in a clear glass housing. It is either part of the fuel pump or located between the pump and the carburetor. The filter element is paper, fiber, metal, or ceramic. The bowl can be removed by loosening the bottom nut and wire bail. Remove the glass bowl and the filter. Replace paper and fiber elements. Metal and ceramic elements can be cleaned in a solvent and dried. Clean the glass bowl, and replace it and the filter element. Tighten the nuts, and check for leaks when the engine is started.

Other Types

Foreign-made cars have various types of filter elements, most of which need periodic servicing or replacement. Many British-made cars have a small metal filter screen located in the float bowl cover of the carburetor. The screen must be removed, brushed, and cleaned in a solvent. It is a permanent type and is replaced after cleaning.

Most electric fuel pumps have a filter screen that needs servicing and cleaning. Remove the filter screen, brush it, and clean in a solvent before replacing.

Selling Filters

Filters are essential replacement parts on the automobile. You should take advantage of every opportunity to sell them, promote them, and give them a prominent part of your stock and displays. Generally, oil filters are stocked and displayed next to the motor oil. Nearby this you should have air filters and fuel filters. Anytime a customer asks for or is shown the motor oil display, you should recommend or call attention to the air and fuel filters.

Replacement filters are fairly inexpensive, but they do an extremely important job. Your selling points on filters should stress that (1) they keep the vital parts of the engine clean and reduce wear and (2) they save money by reducing repair bills and improving fuel economy. Most motorists and car owners are conscious of the need to change oil periodically, but many are not conscious of the need to periodically replace the air and fuel filters. The little bit of money the motorist thinks he or she may be saving is usually eaten up by expensive repair bills and lost fuel efficiency.

A popular television commercial by one of the leading makers of filters has the garage owner saying, "You can pay me now—or pay me later." The implication is that you can pay now for an inexpensive filter—or pay later for an expensive repair bill. Basically, the message is sound reasoning, and you should call it to the customer's attention.

The finest grade and quality of motor oil inside an engine will soon be contaminated with moisture, blow-by gases, and fine metal particles from wear and friction. Without a filter, the dirty oil is coating vital engine parts with abrasives and acids. In other words, the oil itself cannot do its proper lubricating job without a good filter. The filter's job is to trap the contaminants, clean the oil, and let it do its lubricating job. But a filter's cleaning job is short-lived. You should recommend a filter change with every oil change, even if the owner's manual in the car does not specify it. The reason is a sound one. Why have 4 quarts of pure clean oil and a half quart or more of dirty oil still in the old filter? As soon as the engine is started, the clean and dirty oil are mixed. The filter itself may still do some cleaning, but its efficiency is already reduced. For the sake of a few dollars, the expense of the oil change has been increased because the new oil will not do a proper job.

In the same manner, you can recommend air and fuel filters. Their job is to clean the air entering the engine's carburetor and to clean the fuel. Air and gasoline have contaminants, no matter how clean they appear to the eye. Unless properly cleaned, they will cause as much or more wear to vital engine parts as dirty oil.

Any customer for any automotive supply part or service is a candidate for suggested replacement filters. Even if not needed now, it is a good idea to have them on hand for changing when needed. Every motorist should have a supply of filters on hand, or at least have new filters installed when necessary. This is another reason why a complete service record should be kept on each customer. This way, you can tell when filter replacements are needed.

In today's fuel-conscious society, when energy supplies are both limited and expensive, good service is vital. A clean engine runs more efficiently and less expensively. A dirty air filter is not allowing the proper 15:1 air-fuel mixture, so the engine is using too rich a mixture. A clogged fuel filter is letting moisture and rust into the engine, which reduces efficiency and causes unnecessary fuel usage. Clean filters and tight fuel line connections can add plenty of miles to a tank of gasoline. If for no other reason, suggest filters and filter changes for economy, and reduced gasoline consumption.

Questions

1. What are the three major kinds of replacement filters for automobiles?
2. How does the oil filter trap contaminants in motor oil?
3. Why is the paper filter superior to the less expensive types?
4. Name three reasons for changing the oil filter each time the motor oil is changed.
5. How is the bypass filter system cleaned and serviced?
6. How is the full-flow filter system serviced?
7. What purpose does the air filter serve, and why should it be replaced periodically?
8. How do you service the paper air filter?
9. How is the older oil-bath filter serviced?
10. What precaution should be observed when installing a new fuel filter?
11. What are two selling points to stress about replacement filters?

Project

Since filters are a big replacement item, most retailers carry a large stock of them. Ask your training sponsor for the following information:

- What is the normal on-hand stock (quantity) of oil filters, air filters, and fuel filters?
- In each category, how many different sizes are normally carried in stock
- What is the average sales volume (quantity only) of each category of filter?

13

Facts about Automobile Batteries

Objectives: After completing this assignment, you will be able to—

1. explain the function and construction of a battery;
2. tell how chemical action produces electrical energy within a battery;
3. explain the specific gravity rating of electrolyte;
4. explain why a battery loses power and needs replacing; and
5. explain the reserve capacity rating for a battery.

All motor vehicles must have electrical energy to operate. The electrical energy is supplied by an alternator or generator and a wet-cell storage battery. The battery is necessary to operate the electrical system until the engine is turning over at enough speed so that the alternator or generator can take over.

A battery must supply large amounts of electricity at given times. For example, the battery must first crank the engine to start it. It must operate the ignition system when the engine first starts. It must operate the lights, radio, and blower fan, honk the horn, and light the gauges on the dash. It must operate the windshield wipers and make the cigarette lighter glow red hot. When you begin to think about it, there are many electrical demands in the average automobile and truck. As more electrical accessories are added, larger and more powerful batteries are needed.

Batteries in normal use will last only about two years before they need replacing. Replacement batteries are a major part of the automobile accessory business. You must know something about batteries, how they operate, and their capacity if you are going to sell them.

Battery Construction

First, a battery does not store electricity. It *stores chemical energy* that is converted to electricity. A wet-cell storage battery is made up of cells that are connected to one another. Each cell contains several lead and lead-peroxide plates or grids sandwiched together in alternate layers. There is a positive plate, then a negative, then a positive, and so on. There is a small amount of space between each plate or grid. Each cell is divided by separators made of wood, paper, or plastic. To generate chemical energy, the inside of the battery is filled with an acid-water solution called *electrolyte*. The acid is sulfuric acid, in a ratio of about 1:4 (1 part acid to 4 parts water). However, the acid is heavier than water, so by weight the acid is about 36 percent of the solution. It is this ratio or volume that allows an accurate measurement of the battery's strength or generating capacity.

Each cell within a battery is capable of producing approximately 2 volts of electrical energy when the electrolyte is fully charged. A 12-volt battery has six cells, and a 6-volt battery has three cells. Below each cell group is a hollow chamber that collects sediment and spent metal from the grids or plates. Without the collecting chambers, the sediment deposits would create a short circuit between the cells. Bars connect the cells together, and the two outer cells have terminal posts that connect by cable to the electrical system. One terminal post is negative, and the other is positive. The negative post is marked with minus (−) sign, and the positive post with a plus (+) sign. The negative is the ground and is usually attached to the engine block or structural member of the body. The cells are housed inside a hard rubber or plastic sealed case.

How the Battery Works

When the electrolyte circulates between the positive and negative plates, it remains as an acid-water solution. When a switch is turned on in the auto's electrical system, this forms an external circuit that terminates at the battery. The instant that the battery is called on to supply an electrical current, the acid-water solution turns to lead sulfate, drawing current from the galvanic action between metals. In other words, when a circuit is completed that ends at the battery, the battery instantly converts stored chemical energy into electrical current.

Why Batteries Weaken and Fail

Why can't batteries be made to last forever, or at least for the life of the automobile? Your customers will probably ask that question or ones like it. You should be able to give a logical, factual explanation. No wet storage battery can last indefinitely with

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Illustrations in this assignment are provided courtesy of the Association of American Battery Manufacturers.

present battery technology. Here is the reason.

When a battery is called on to supply electrical current, the acid in the electrolyte is weakened by a small amount. The constant activity between the grids or plates also decomposes some of the lead peroxide and spongy lead materials. With each use, then, the battery loses some of its original power and strength. It can remain functional for only a certain length of time. The strength of the battery is measured by the specific gravity of the electrolyte solution. It can be checked with a hydrometer (hy-DROM-uh-ter) or with capacity load test equipment. The hydrometer is used where there are vent caps on top of the battery.

Other reasons for early battery failure are improper maintenance and faulty electrical equipment. A short circuit anywhere puts an excessive drain on the battery, causing it to discharge current at an abnormal rate. A tiny light bulb that remains on will pull current away from the battery. To be effective, the grids and plates must be completely covered with electrolyte. Too few car owners inspect and fill the cells to proper levels. Corrosion buildup on the terminal posts causes poor electrical connections and unnecessary power drains. Overfilled cells weaken the electrolyte and create more corrosion from acid spills and boilover when the battery is receiving the charging circuit. Cracks in the battery case, broken terminal posts, and heavy mineral deposits inside the battery case create

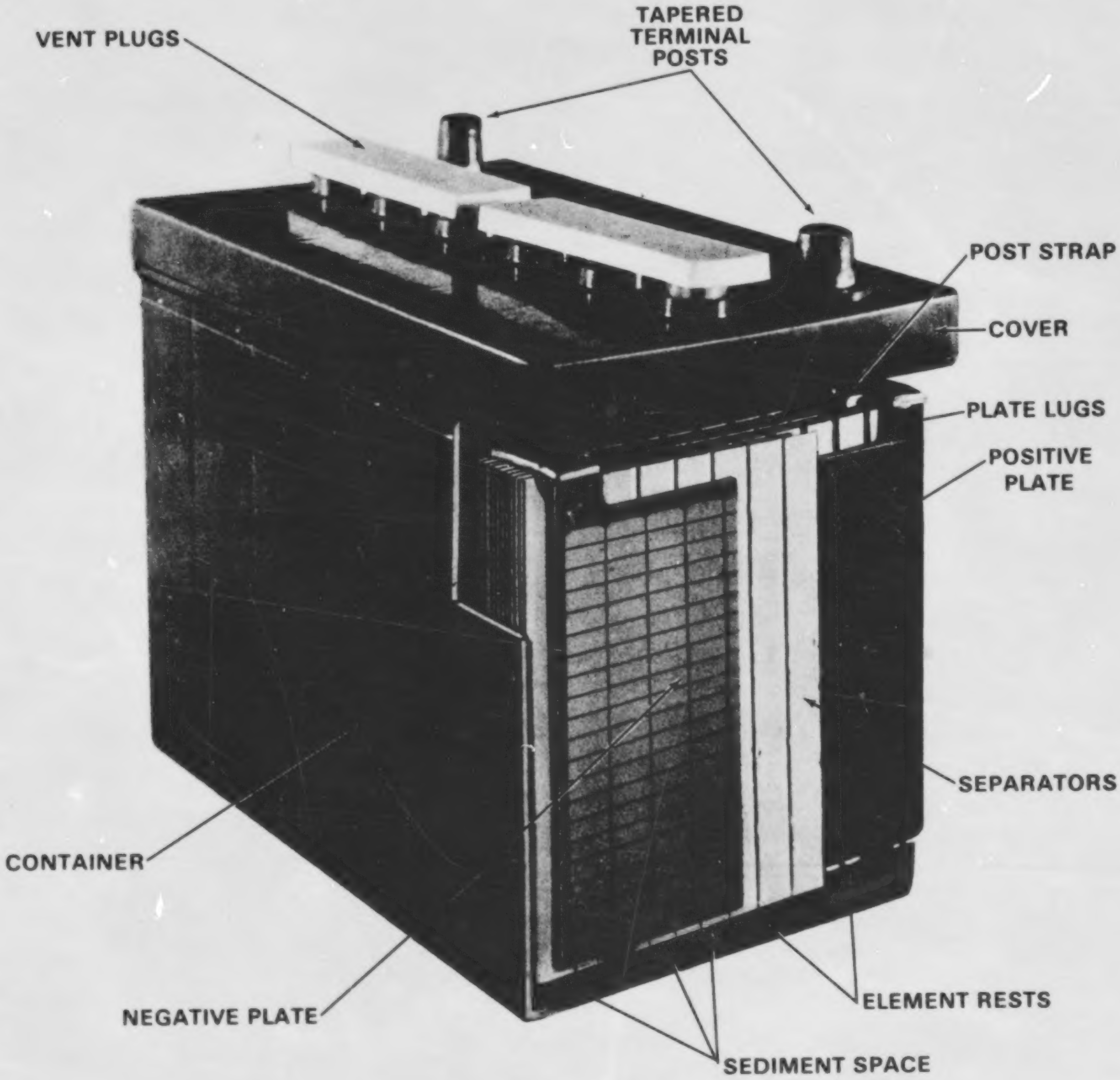


Fig. 13-1. Battery construction

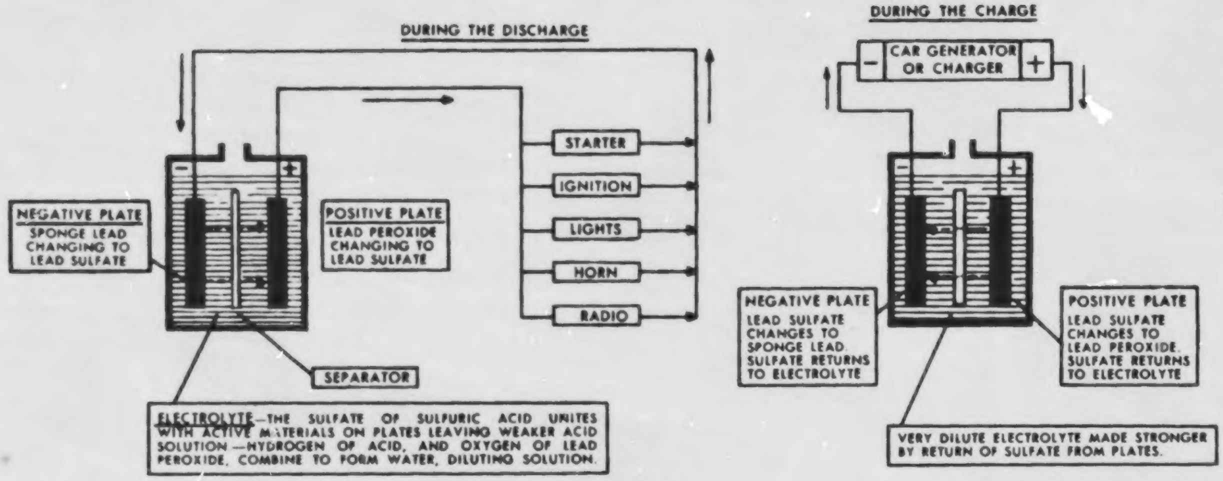

DURING THE DISCHARGE
NEGATIVE PLATE
SPONGE LEAD CHANGING TO LEAD SULFATE
POSITIVE PLATE
LEAD PEROXIDE CHANGING TO LEAD SULFATE
STARTER
IGNITION
LIGHTS
HORN
RADIO
SEPARATOR
ELECTROLYTE—THE SULFATE OF SULFURIC ACID UNITES WITH ACTIVE MATERIALS ON PLATES LEAVING WEAKER ACID SOLUTION —HYDROGEN OF ACID, AND OXYGEN OF LEAD PEROXIDE, COMBINE TO FORM WATER, DILUTING SOLUTION.
DURING THE CHARGE
CAR GENERATOR OR CHARGER
NEGATIVE PLATE
LEAD SULFATE CHANGES TO SPONGE LEAD. SULFATE RETURNS TO ELECTROLYTE
POSITIVE PLATE
LEAD SULFATE CHANGES TO LEAD PEROXIDE. SULFATE RETURNS TO ELECTROLYTE
VERY DILUTE ELECTROLYTE MADE STRONGER BY RETURN OF SULFATE FROM PLATES.

Fig. 13-2. How the battery does its job

short circuits and power loss. In the latter case, too many car owners use regular tap water with mineral content rather than distilled water to fill cells.

How a Battery Is Charged

Obviously, a battery that constantly discharged but could never be recharged would soon fail. Here is the way that the battery receives a longer life through a recharge circuit.

1. The car door is opened, and the switch turns on the dome light. The battery supplies current, or discharges.

2. The ignition key turns on the ignition switch to start the engine. The starter motor draws a high rate of current from the battery, or heavy discharge.

3. When the engine starts, the ignition system must draw enough current to fire each spark plug. This is another power drain on the battery.

4. If the headlights, radio, blower fan on heater or air conditioner, or other accessories are operating, these are additional heavy power drains on the battery's capacity.

5. At slow speed, the engine is turning over a low number of rpms (revolutions per minute), and drive belts are turning the alternator or generator. At low speed, the alternator is producing partial electrical current for the operation of the ignition and accessories, but the battery is having to supply the rest of it. A voltage regulator tells the battery how much current it must supply.

6. As the car moves faster and gets up to about 30 miles per hour, the alternator and generator are producing all of the current needs. The battery is resting.

7. At higher speeds, the alternator is generating current faster than needed, so some of that current can be returned to the battery in the form of a charging circuit. Here, the electrical current flows in reverse through the battery's cells. The lead sulfate solution becomes electrolyte, and the lead peroxide and spongy lead that was taken from the plates during discharge is now redeposited from the solution back into the plates. However, there is never as much redeposited as was taken away during discharge. This means that the battery gets weaker with each use, even though it is by a very small amount.

8. In stop-and-go city driving, the engine never quite develops full generating capacity on the alternator or generator. The battery is called on constantly to fill the electrical system needs. In highway driving, once the car reaches moderate speed and above, the battery can rest completely and be recharged. Thus, two batteries that are exactly alike will last different periods of time, depending on their use. A battery used mostly for highway driving will last much longer than one used mostly for city driving.

Battery Capacity

Are all batteries alike? Isn't one 12-volt battery as good as another? Certainly not. Batteries have the same voltage, but not the same capacity for producing that voltage. Voltage measures the pressure that pushes the electrical current through the system. Voltage for electricity compares with water pressure in a pipe. The capacity for generating electrical energy is measured in amperes (amp) or ampere-hours (amp-hr).

Each cell within a fully charged battery will develop approximately 2.1 volts of current. The amperes of capacity of each cell is determined by a number of things. The larger and heavier the grids or plates, the longer the battery will generate current. The more volume of electrolyte that circulates among the plates, the longer the generating capacity will be. Battery capacity is measured by three main methods.

Ampere-Hour Rating

The oldest method of rating a battery's capacity is the ampere-hour rating. It is also known as the 20-hour rating. It measures the steady flow of current for a period of 20 hours when the temperature is 80°F. The flow must remain steady without any cell falling befow 1.75 volts for 20 hours. For a 12-volt battery, the total output must not be below 10.5 volts. If a battery will deliver 3 amperes of current for 20 hours without a voltage decrease below 10.5 volts, then it would be rated a 60-ampere-hour battery.

Reserve Capacity

A newer method of rating battery capacity is its reserve strength. The reserve is listed in number of minutes that the battery will supply enough current to keep all of the car's accessories operating. For example, the reserve may be listed as 68, 81, 86, 101, or 105. The number *81* on a battery means that it will give a fully supply of amperes and voltage for a period of 81 minutes continuous discharge when the temperature is 80°F. The larger the number, the greater the reserve capacity or strength.

Cold Cranking Rating

Another method is to measure the battery's ability to crank an engine when the air temperature is 0°F. Under these conditions, the engine's oil is cold and stiff, which makes cranking more difficult. Also, under very cold conditions, metal expands, so the pistons and cylinders have a tighter fit. This creates a greater strain on cranking power. Such a battery rating would be measured as 305, 315, 380, or 440. These figures represent the current flow a battery can deliver for 30 seconds at 0°F, while maintaining a voltage of 1.2 volts per cell or higher. The higher the number, the greater the generating strength of the battery.

Specific Gravity

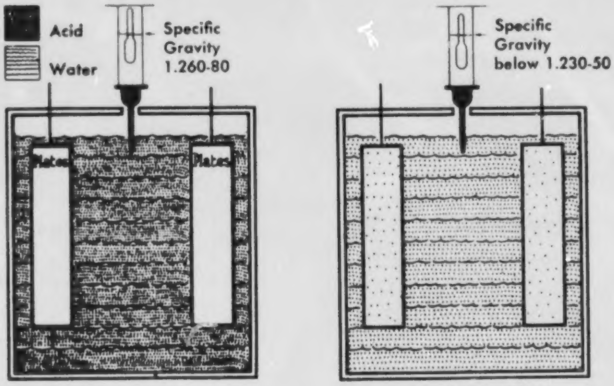
When a battery is at full strength, the electrolyte inside will have a specific gravity rating of 1.260 or 1.280. Specific gravity measures the ratio of acid volume to water. Acid is heavier than water. On a balance scale, a pint of acid would be 1.26 times heavier than a pint of water, thus making the specific gravity rating.

The Hydrometer

To measure the specific gravity of electrolyte, a hydrometer is used. A syringe type of device, the hydrometer has a large glass cylinder or barrel with a narrow opening on one end and a rubber bulb at the other. Inside the glass barrel is a float device with a scale inside. By inserting the narrow opening into the battery's vent hole and squeezing the rubber bulb, siphon action will raise the electrolyte into the glass cylinder. The float will rise inside the barrel to indicate the relative strength of the electrolyte. The following scale indicates the strength of the battery.

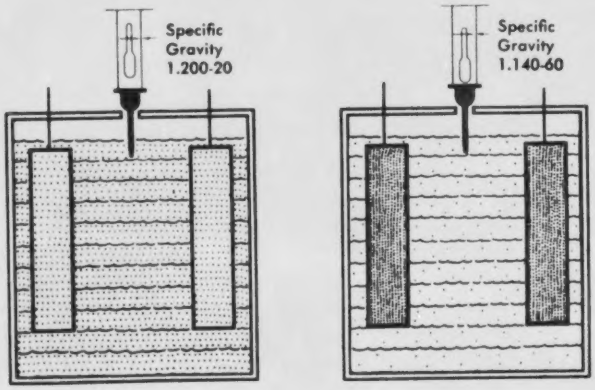
Specific Gravity	*Strength*
1.260 to 1.280	100% charged
1.230 to 1.250	75% charged
1.200 to 1.220	50% charged (weakening)
1.170 to 1.190	25% charged (failing)
1.140 to 1.160	unsafe, needs replacing
1.110 to 1.130	discharged or dead

When testing a cell, the hydrometer must be held vertically with the glass barrel full of electrolyte. A partially filled barrel will not give an accurate reading. After several uses, the hydrometer should be flushed with soapy water. Otherwise, the float will stick to



FULLY CHARGED
Acid in water gives electrolyte specific gravity of 1.270.

GOING DOWN
As battery discharges, acid begins to lodge in plates. Specific gravity drops.



UNSAFE!
Battery half discharged. More acid in plates, less in electrolyte. Starting failure in sight if battery is allowed to remain in car.

DISCHARGED
Acid almost entirely in plates, leaving weak electrolyte behind. Specific gravity lower, almost that of water.

Fig. 13-3. Why batteries weaken and fail

the sides. Check the float for signs of a crack or leak, which will cause an inaccurate reading. Most floats have a paper inside with a printed scale. If the paper appears wet, this indicates a leak in the float.

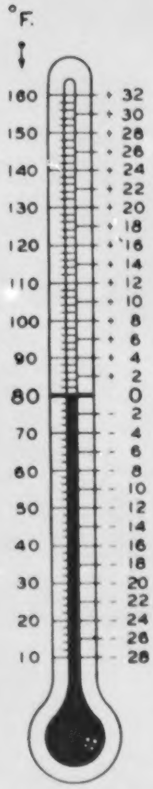
Temperature Corrections

No accurate reading of a hydrometer scale can be made without knowing the temperature of the electrolyte. Most accurate readings should be made at 80°F. If a battery has been under charge or used in a car, its temperature will usually be over 90°F. In very cold conditions where the battery has been exposed to outside air, its electrolyte will probably be at 70°F or below. Acid volume expands with heat and contracts or decreases with cold. Hot temperatures makes the electrolyte less dense, and the float tends to settle more in the glass barrel. In cold temperatures, the electrolyte is more dense, and the float tends to rise higher than normal.

Many hydrometers have a built-in thermometer that measures electrolyte temperature while measuring specific gravity. When the temperature is 90°F or above, *add 0.008* specific gravity to the reading. When the temperature is 70°F or below, *subtract 0.024* specific gravity from the reading.

Battery Types

Batteries are shipped from the factory either wet-charged or dry-charged. A wet-charged battery has electrolyte inside. The dry-charged battery must have the electrolyte added when it is sold. From a storage standpoint, dry-charged batteries are best. A wet-charged battery will completely discharge itself within 90 days if stored in a room at 100°F. The reason is that as long as the electrolyte makes contact with the plates, some chemical activity is taking place and the battery is slowly losing power.



EXAMPLE No. 1 —
Temperature below 80°F.
Hydrometer Reading 1.250
Acid Temperature 20°F.
***Subtract* .024 Sp. Gr.**
Corrected Sp. Gr. is 1.226

EXAMPLE No. 2 —
Temperature above 80°F.
Hydrometer Reading 1.235
Acid Temperature 100°F.
***Add* .008 Sp. Gr.**
Corrected Sp. Gr. is 1.243

Fig. 13-4. Corrections in hydrometer readings must be made in extreme temperatures.

When placing a dry-charged battery in a car, fill the cells with electrolyte after installing it. If some of the electrolyte spills, it will be in an area where it can be flushed with water and cause little damage. Inside, the electrolyte will ruin floors, shelving, or the display stand. Electrolyte is packaged in a container for easy filling if you use care and read the directions.

The design of a battery can be of three main types. (1) Older batteries have vent caps on top and top-mounted terminal posts. Newer types are either (2) the types with side-mounted terminals with vent caps or (3) the newest maintenancefree types with side-mounts but no vent caps.

The older top-mounted types have corrosion problems. Vent gases have acid vapors that corrode the terminals and connecting cables. In damp weather, the corrosion causes unnecessary power drain and poor connections that make hard engine cranking. The newer side-mounted terminals eliminate the corrosion problem with terminals. The connectors screw in and have a plastic shield. However, vent caps can cause corrosion on battery hold-downs, surrounding parts, and the battery support case.

The newest maintenancefree batteries eliminate two big problems. First, there are no vents to cause corrosion, and, second, there is no need to add water to the cells. To relieve high pressure from generating gases, small vent holes are located underneath the battery case top.

When a battery is charging, it produces some oxygen and some hydrogen. Under certain conditions, these are highly explosive. A faulty battery can explode while operating in the car. A spark or electric arc can set off an explosion under the hood.

Some batteries have heat shields for certain kinds of automobiles, depending on the battery's location or placement. If it is next to the exhaust manifold, a shield is necessary to remove the heat. Most heat shields duct cooler air in and around the battery case. Heat is the biggest enemy of the battery and causes it to lose power faster than any other factor. For normal servicing, the heat shield is left intact. When the battery is replaced, make sure that you replace the shield and keep all parts in their proper location for maximum cooling.

Questions

1. What purpose does the battery serve in the automobile?
2. How is a battery constructed to generate chemical energy?
3. How does the battery work to produce electricity?
4. Why does a battery begin weakening as soon as it is used?
5. What are some of the most common reasons for early battery failure?
6. How does a recharge circuit put power back into a battery?
7. Why will two batteries exactly alike have different life spans?
8. What is the difference between voltage and amperes?
9. Explain the reserve capacity rating for batteries.
10. How is the specific gravity rating related to the strength of a battery?
11. What corrections are made on the hydrometer when the electrolyte temperature is above and below normal?
12. What danger is present when a battery is charging?

Project

From your training station's stock of batteries, select ones of good, better, and best quality. After studying all the data you can find, list the superior selling points of the best battery over the better one. List the superior selling points of the better one over the good one.

14

Inspecting, Servicing, and Selling Batteries

Objectives: After completing this assignment, you will be able to—

1. cite special safety precautions needed to service and handle batteries;
2. state the reason for routine visual inspection of a battery;
3. describe how to conduct a capacity load test;
4. state the advantage of an electronic battery tester; and
5. list five symptoms of a failing battery.

Battery Safety

In handling automotive batteries, you must be aware of the dangers and know how to prevent accidents.

First, the electrolyte in the battery is sulfuric acid and is extremely corrosive. It can quickly ruin the paint or finish on any metal, wood, tile, or other fine surface. Acid spills cause paint to come off quickly and the metal underneath to be eaten away or rust. Acid spills on the skin are serious. They must be treated immediately.

Wherever acid spills, flood the entire area with plenty of clean water as fast as possible. Acid burns on the skin should be flooded with a stream of clear water. After flooding the skin, pack it with baking soda. Acid in the eyes should first be treated with water, then with a 1 percent solution of baking soda and water. Do not rub the eyes, but seek medical attention immediately. Go to a doctor's office, emergency clinic, hospital, or first aid station if one is nearby.

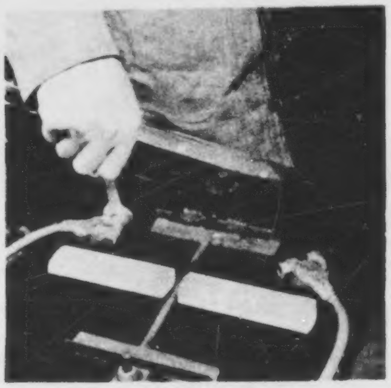


Fig. 14-1. Use the proper tools when removing or installing a battery.

If acid spills on clothing, flood it with water and remove the clothes as quickly as possible. Acid spills on small areas of the automobile can be flooded with water and treated with a baking soda solution. If treated immediately, the paint can be saved from permanent damage. On the exterior finish, a brisk rubbing with compound will probably restore the brightness and shine.

If you are charging a battery, it is probably giving off hydrogen gas, which is highly explosive. Any small spark, electric arc, cigarette, or match nearby can touch it off. In all top-vented batteries, some hydrogen gas is present all of the time. To prevent possible explosion, follow these safety rules:

- Wear safety goggles to protect eyes, and an apron to protect clothing.
- Never work under the hood of an automobile with lighted cigarettes, matches, or open flames. Any small fire can quickly spread to other areas where gasoline is present.
- Use battery charging equipment only in a well-ventilated area.
- Be careful with tools, and never short across the battery terminals to see if the battery is active.
- Never connect or disconnect the leads from the battery charger to the battery terminal posts while the charger is turned on.
- Never work on or around a battery with a watch or ring on. Either one can cause unintentional arcing and possible burns.

Batteries are very heavy for their size because of the great amount of lead in the plates. Carrying them can be dangerous unless you handle and lift them properly. If dropped, the case will likely crack open and spill acid on you and the surrounding area. Always use a battery carrier until the battery is in place. Lift with care to avoid back

Fig. 14-2. Use caution when tightening nuts on the side-terminal battery.

strain or hyperextension of the shoulder and arm muscles.

A weak battery's electrolyte will freeze in temperatures below 30°F. A fully charged battery will not freeze unless the outside temperature drops to around -60°F. Before charging or boost-starting a dead battery in winter, check the electrolyte to make sure it has no ice crystals or other signs of freezing. Where its condition is unknown, let the battery thaw at room temperature for a few hours before passing current through it. Charging a frozen battery will ruin it.

Inspecting Batteries

Good battery care requires constant service and attention. Any battery can be made to last longer by giving it the proper attention and keeping it clean, filled properly, and checked for cracks, corrosion, and faulty cable connections. When checking or inspecting a battery installed in a car, follow these steps:

1. Check the electrolyte level first. This requires removing the vent caps from each cell and looking inside. The fluid level should be at the full mark or ring just inside each vent well. Add only distilled water to the cell's vent well. Do not overfill.

2. Check the terminal connections next. Wire-brush any corrosion or collection of oil and grease. Wiggle the cable connections to see if they are tight. Signs of heavy corrosion should be removed. Remove the cables. Neutralize the corrosion buildup with a baking soda solution and stiff-bristled brush. Use the solution on all signs of corrosion. Flush with clear water. Use terminal post brushes to remove oil, grease, and corrosion from the terminal posts. Inspect cable connections for signs of broken wires, fraying, and worn-out insulation. Replace damaged cables and connections. Make sure you reconnect cables properly—positive to positive and negative to negative ground.

3. Inspect and clean the battery hold-down. If there is a heavy buildup of corrosion and dirt, remove the battery, and remove the corrosion from the battery holder bottom pan. Flush with clear water, and air-dry. Be careful that corrosion does not remain on any metal or painted surface.

4. Look the battery case over carefully for signs of damage and cracking. Any apparent damage on the outside means that the battery is likely defective and should be replaced. Check for missing vent caps, and replace those.

5. Use a special corrosion-fighting spray or paint on all battery connections at the terminal posts and bolt-and-screw assemblies on the hold-downs.

6. When removing a battery from the car, use a cable puller tool to remove the cable connectors from the terminal posts. Remove the negative ground cable first, then the positive. When reconnecting the cables, connect the positive cable first, then the negative ground. Tighten connectors securely. An absolute tight fit on a clean post is necessary for good electrical contact.

7. When using baking soda solution for cleaning, make certain that none gets inside the vents on top. Soda neutralizes acids. If cleaning the top of the battery, stop the vent holes temporarily to make sure no water or corrosion from the top gets in. Remove the stops from the vent holes immediately after cleaning. If you leave them in, you may cause a gas explosion.

8. Check the electrolyte's strength with a hydrometer. Information on readings is given in Assignment 10. For a maintenancefree battery with no vent caps, you must use electronic test equipment.

Testing and Charging Batteries

Terms You Should Know

Before using any kind of battery or electrical test equipment, there are some electrical terms you should know.

ampere—the unit of measure for current flow. It is measured by an ammeter.

ampere-hour—a unit of measure for battery capacity, obtained by multiplying the current flow in amperes by the time in hours during which the current flows. For example, a battery that delivers 3 amperes for 20 hours is delivering 60 ampere-hours (3 × 20 = 60).

direct current (**DC**)—a continuous, unidirectional, nonpulsating current that is produced by storage batteries. A generator produces direct current to charge a battery.

alternating current (**AC**)—an alternating pulsed current. An alternator produces alternating current, but diodes change it to direct current for operating the electrical system and battery charging.

ohm—the unit of measure for resistance to current flow.

volt—the unit of measure for electrical pressure. It is measured by a voltmeter.

watt—the unit of measure for electrical power. It is found by multiplying the amperes by the voltage: watts = volts × amperes. 3 amperes × 12 volts = 36 watts of power.

Capacity Load Test

This test uses an ammeter, a voltmeter, and a variable or fixed resistance pile. The test is to see how a battery will perform under load and if it is strong enough to start the engine and maintain ignition. The instrument used is a battery starter tester. Before using, make sure you know how to use the equipment and how to read the dials. Follow the manufacturer's directions and instructions for use.

Hook up the tester's leads to the battery. Make sure you have them in the right order so that you do not cross the polarity. Crossing polarity means to cross negative and positive leads. You can ruin a battery or short out an entire electrical system by crossing polarity.

The electrolyte in the battery should be 80°F, or at room temperature. The tester control should be in the off position. If you are testing a side-terminal battery, you must use special adapters.

Read the battery's specification label, or look it up on the table to determine the ampere-hour rating. For example, assume the ampere-hour rating is 80. Turn the tester control

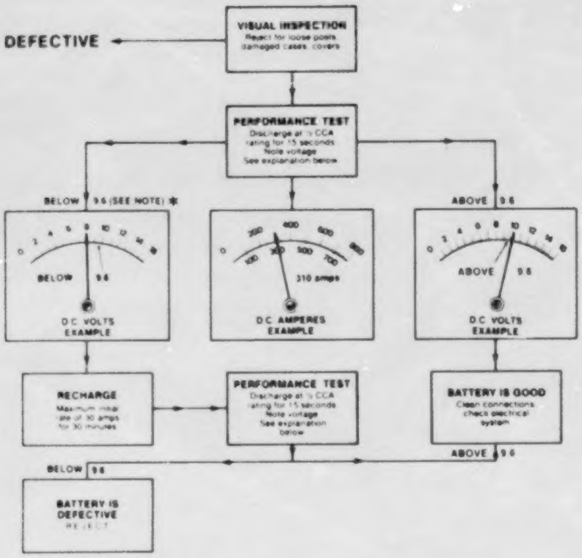

DEFECTIVE
VISUAL INSPECTION
Reject for loose posts damaged cases, covers
PERFORMANCE TEST
Discharge at ½ CCA rating for 15 seconds
Note voltage
See explanation below
BELOW 9.6 (SEE NOTE) *
0 2 4 6 8 10 12 14 16
BELOW 9.6
D.C. VOLTS EXAMPLE
0 100 200 300 400 500 600 700 800
310 amps
D.C. AMPERES EXAMPLE
ABOVE 9.6
0 2 4 6 8 10 12 14 16
ABOVE 9.6
D.C. VOLTS EXAMPLE
RECHARGE
Maximum initial rate of 30 amps for 30 minutes
PERFORMANCE TEST
Discharge at ½ CCA rating for 15 seconds
Note voltage
See explanation below
BATTERY IS GOOD
Clean connections check electrical system
ABOVE 9.6
BELOW 9.6
BATTERY IS DEFECTIVE
REJECT

Fig. 14-3. The capacity test sequence

knob to draw current at *three times* the ampere-hour rate. In this example, the control knob would be set at 240. Maintain this current draw for 15 seconds. Turn off the control immediately. The voltage should not have dropped below 9.6 on a 12-volt battery or 4.8 on a 6-volt battery. If the readings are below this level, it indicates the battery is failing and in need of replacement.

Alternative Capacity Test

If a battery starter tester is not available, you can use the auto's starter motor. First, remove the high-tension lead from the center top of the distributor cap, and ground it with a jumper wire. Connect a voltmeter to the battery terminals, making sure you do not cross polarity.

Crank the engine continuously for 15 seconds. Then look at the voltmeter reading. If it is below 9.6 on a 12-volt battery or 4.8 on a 6-volt battery, then the battery is defective, failing, and in need of replacement.

Three-Minute Charge Test

If you have a discharged battery, you need to determine if the battery can be revived, or if it has failed to the point of needing replacement. Hook up a fast-charging machine to the battery. Again, make certain you have the positive to positive and negative to negative leads in their proper order. If a battery is discharged, it has a high deposit of sulfate on the plates. A 3-minute fast charge will dislodge sulfate buildup on the plates and allow current to be generated by the electrolyte. If the battery is defective, the voltage will not knock off the sulfate. If a high amount of voltage is registered during the 3-minute charge, turn off the machine and disconnect it from the battery. Otherwise, the electrolyte will begin to boil inside the battery.

If you conduct the test on the battery when it is in the car, then follow these steps:

1. Disconnect the battery cables from the terminal posts. If you leave them on, you will likely damage the alternator and electrical system. If you register high voltage on the charger during the test, stop the machine immediately and disconnect the leads. High voltage is an indicator that the sulfate buildup on the plates is too excessive and has created a short inside the battery.

2. If the voltage is normal, hook up the leads to the battery posts, and turn the charger on for its highest charging rate. It should not exceed 40 amperes for a 12-volt battery or 75 amperes for a 6-volt battery. Leave it on for 3 minutes.

3. Read the voltmeter. If the voltage does not read above 15.5 volts for a 12-volt battery or 7.75 volts for a 6-volt battery, then the battery can be safely charged to the manufacturer's recommended charging rate. If the voltage exceeds that mentioned above, the battery is defective and will not hold a charge long enough to operate in the vehicle.

Electronic Battery Tester

This device measures the available power of a battery. It uses either ampere-hour, cold cranking, or watts rating method. A battery rating selector switch lets you select any of the three methods that you want. You select the one method for which you know the battery manufacturer's rating. It will also measure power in kilowatts and has a voltmeter to determine the state of charge.

The advantage of the electronic tester is that you don't have to make any kind of compensation, temperature adjustment, or calculation. There is no need to discharge, disconnect, or load the battery. The dials are easily read and give an accurate reading. It is ideal for the newer maintenancefree batteries and those with side-mounted terminals.

Battery Charging

A battery charge revives a weak battery back to its full charge capacity. It can be done when the plates are not damaged or when no sediment deposits have created a short circuit inside. If the battery is defective or damaged, or if the plates are corroded, the battery will not hold a charge.

The charging current is rated in amperes, and it is timed. A 60-ampere battery would receive a 20-ampere charge for 3 hours. They are charged at rates from 3 to 50 amperes. The lower the amperes, the longer and slower the charge. Fast charges of high amperes are used mostly by service stations and garages to get a vehicle moving in the shortest period of time. Slow charging is done overnight or during a 24-hour period and is considered the best kind for the battery.

Where a vehicle is not driven very often and spends a great deal of time in a garage, a trickle charger can be attached to the battery. This compensates for normal discharge drain and keeps the battery at full charge when not operating. A battery can be charged at any rate and with any amount of current flow as long as the electrolyte does not spew or boil over.

Check the electrolyte level in the battery before charging. It should just cover the cell separators. Below this level will damage the plates. Above this level will cause spewing and boilover. Use a hydrometer or bulb-type syringe to remove the electrolyte. Put it in a clean plastic or glass container. After charging, it can be put back into the battery. Leave vent caps in place during charging, but make sure the vent holes are open. Hydrogen gassing will be heaviest during the charge cycle. All charging should be done in a well-ventilated area. Never use charging equipment in closed-in storerooms.

A charging machine should be plugged in to an outlet that has nothing else on that circuit because the ampere draw is heavy. If the charger is not getting full amperes from the current, the charging time will be greatly increased. If an extension cord is used, make sure it is heavy enough to carry the current load. It should not be over 25 feet long, and it should be the three-wire type that is properly grounded.

For your safety and protection, observe these rules while charging a battery:

- Never charge a battery in a closed-in space. The area should be open and well ventilated.

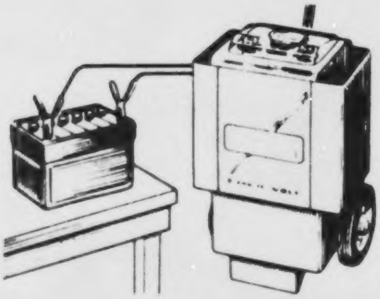


Fig. 14-4. Charge batteries only in the open or in a well-ventilated area.

- Never connect the charger to the power source until you have made the connections from the charger equipment to the battery terminals. Never disconnect the leads from the battery terminals until you have unplugged the charger from its power source.
- Never charge a frozen battery or one that has a low electrolyte level.
- Never try charging a battery where there is excessive voltage across the battery terminals. Disconnect the equipment.
- If you are charging a battery in a vehicle, first disconnect both positive and negative cables. If you leave them in place, you will damage the generator, alternator, and electrical system.
- For maximum safety, wear eye goggles and an apron for protection from acid spills.
- While charging, take electrolyte readings and temperature readings. If the temperature rises above 125°F, shut off the charger. Check the voltage with a voltmeter. If it exceeds 15.5 for a 12-volt battery or 7.5 for a 6-volt battery, shut off the charger. Lower the charging rate, and extend the time.
- After charging, check the electrolyte readings for three solid hours. The specific gravity should hold at 1.260 or 1.280 for 3 hours. If it does not, the battery will fail again in a short time.
- After the charging cycle is completed, clean off any acid spills or spewing that has come from the vents. Reconnect the cables, and visually inspect the battery to make sure everything is in place. Check again to see that the positive and negative cables are in the right order before starting the engine.

If you are using a fast-charge rate, follow these precautions:

- Never fast-charge if the battery has failed the 3-minute charge test.
- Never fast-charge if the battery has heavily sulfated plates or shows physical damage.
- Constantly monitor the electrolyte to make sure it does not exceed 125°F.

Jump-Starting with Booster Cables

In emergencies and where a road-service truck is used to get a stalled vehicle moving, jump-starting is a quick, easy method. It requires a set of jumper cables and another battery, preferably one that is already in use and hooked up to a charging circuit. Follow these procedures:

1. On the stalled vehicle, set the hand brake, and move the gearshift lever to neutral or park. Pull the front of the rescue vehicle as close to the side or front of the stalled vehicle as possible. Set its hand brake, and put the shift lever into neutral or park.

2. Attach one cable to the terminal that goes to the starter motor or solenoid. Do not connect to the grounded cable first. Make sure, when attaching the other end, that positive goes to positive and negative to negative. Attach the ground cables last.

3. With cables attached, speed up the engine on the rescue vehicle so that the battery is receiving a full charge. Then begin cranking the engine on the stalled car. As soon as the engine starts, remove the cables. Remove the ground cable on the stalled car first, then remove it from the booster battery. Remove the positive cable from the booster battery, then from the stalled vehicle.

4. Turn the stalled vehicle's engine over at a high rate for a few seconds to get a maximum charge on the battery. As soon as possible, bring that vehicle in for battery inspection, testing, and recharging.

Selling Batteries

From routine inspection and servicing, you can tell if a battery needs replacement. Assume that your customer is not aware of the battery's true condition. It is your duty to tell the customer that a replacement battery is needed and why. These are symptoms of a failing battery:

1. Engine is hard to start. It takes several cranks each time.
2. Lights dim if engine is idling.
3. There is a hesitation in starting.
4. Fuses blow out often.

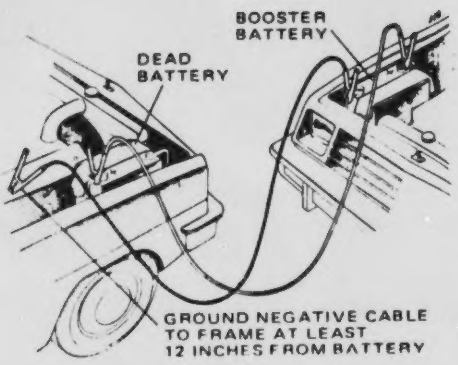

BOOSTER BATTERY
DEAD BATTERY
GROUND NEGATIVE CABLE TO FRAME AT LEAST 12 INCHES FROM BATTERY

Fig. 14-5. The proper method of jump-starting a weak battery.

5. Blower fan slows down when engine idles.

If a battery appears to be in poor condition and the specific gravity reading is low, ask the customer if he or she is having any of the above problems. Any or all of these indicate that the battery is probably faulty. Poor maintenance and heavy corrosion buildup show that a battery has had little care. If it is excessively dirty, corroded, and crusted with oil and dirt, you can assume that it has had little care or maintenance. All of these mean that the battery is probably in poor condition.

While heat is the great enemy of a battery, it is usually when cold weather begins that batteries fail. The reason is that cold weather makes engine cranking much harder. For example, a fully charged battery at 32°F has only 65 percent of its available power. Cold weather greatly reduces the electrolyte's ability to produce chemical energy from the plates. At 0°F, the battery has less than half its potential power available.

Motor oil stiffens considerably in cold weather, and this requires far more power to crank the engine than in warm weather. For example, if an engine has a 10W-30 motor oil, it requires less than half the power to crank the engine at 80°F than it does at 0°F. It requires one and a half times more cranking power at 32°F than at 80°F.

Cold weather is the best time to begin recommending a replacement battery to the customer. If a battery is weakening and has half or less of its full charge left, it will likely fail before winter is over. If a battery is 2 years or older, it should be checked and inspected to determine how long it will last. A dead battery at the wrong time can leave a motorist stranded.

Recommend the right size and capacity to the customer. Most batteries are sold by the number of months of guarantee, such as 12, 24, 36, 48, or 60. Some batteries are guaranteed for the life of the car. The longer the guarantee, the more capacity the battery has to generate power. Batteries are sized by the ampere-hour rating or cold cranking rating. You should recommend a battery that will take care of the engine size and the load put on it. A strong battery is needed for accessories such as air conditioning, CB radio, and stereo or tape unit, and for pulling a trailer or other load with additional lighting.

If the customer plans to drive the vehicle for at least 2 years, then you should recommend your best and strongest battery. Explain the power ratings, ampere-hour output, grid or plate size, extra reservoir for electrolyte, and particularly the new maintenancefree types that require no refilling.

Questions

1. What special precautions should be observed in handling and servicing batteries?
2. What is the danger of charging batteries in very cold temperatures?
3. What is the purpose of routine visual inspection of a battery?
4. What special precautions should you observe when using baking soda to clean a battery?
5. Define *ampere, volt, ohm,* and *watt* as they apply to a battery.
6. Briefly describe how to conduct a capacity load test.
7. If you don't have a starter tester, what can you use to conduct a capacity load test?
8. What does a 3-minute charge test do to activate a discharged battery?
9. What is the advantage of an electronic battery tester?
10. What is the difference between a fast charge and a slow charge?
11. Name five symptoms of a failing battery.

Project

Describe the battery testing equipment used at your training station. How is it used? Give the procedure that is recommended by the manufacturer. Are there any special precautions or safety rules to follow? Prepare a brief report on this testing equipment, and attach it to this assignment.

15

Facts about Tires

Objectives: After completing this assignment, you will be able to—

1. discuss the basic parts of an automobile tire;
2. explain the differences between bias-ply, bias-belted, and radial-ply construction;
3. relate how tires are sized and what each number and letter means; and
4. describe the stress tests that a tire must pass.

The single most important item you can sell is tires. They account for the largest volume of sales in TBA (tires, batteries, accessories). To be able to sell a tire, you must know all about them, how they are made, the sizes, types, designs, measurements, uses, and expected wear factors. Selling tires requires an extensive amount of knowledge. This assignment will give you basic information on tire construction, types, sizes, materials, and other related technical facts.

Basic Tire Construction

Tire Parts

Figure 15-1 shows a cross section of a typical tire. Six parts are important.

Tire beads are strands of high-tensile strength steel wire. When the tire rotates in travel, especially at high speed, the rotation has a tendency to throw the tire off the rim of the wheel. The beads hold the tire shoulder tightly to the rim. Air pressure inside the tire forces the bead closely to the rim shoulder so that air pressure cannot escape, and it keeps the tire on the wheel. Bead construction is essential in tubeless tires.

The **cord body** is made up of layers or **plies** of rubber-impregnated fabric. Plies can be of rayon, nylon, or polyester. The plies of fabric are laid on top of each other and are bonded so that they form a compact, durable unit. In a bias-ply tire, the layers of fabric run diagonally from bead to

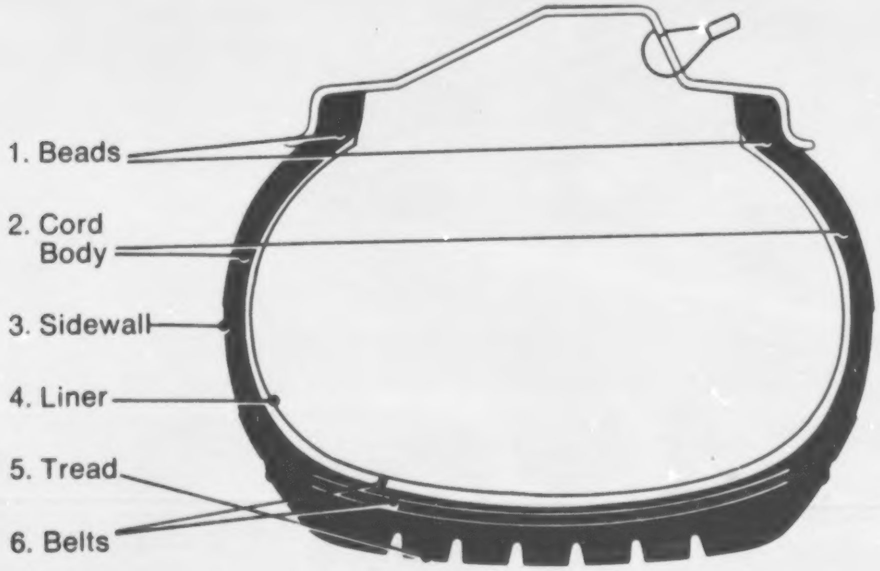


Fig. 15-1. The parts of a tire

bead. Each layer runs in an opposite direction. In a radial-ply tire, the plies of fabric run radially or around the tire. In tire construction, the alternating layers give strength to flex and help prevent sidewall damage.

The **sidewalls** of the tire must be flexible while holding in the excessive pressure and heat. All of the strain is on the sidewall. It must carry the load weight, flex, absorb shocks, run cool, resist cuts and abrasions, and not crack open from extreme weather conditions. Some types of tires have greater sidewall flex and strain than others.

The **liner** is a thin layer of special rubber applied to the inside of the first layer of ply of fabric. Its main purpose is to create an airtight seal and keep the pressure inside the tire.

The **tread** is the part of the tire that makes direct contact with the road. Tread rubber is made of natural and synthetic rubbers with carbon black for maximum wear and traction. Tread designs vary as to tread depths. Treads are molded into a series of ribs and grooves to give traction in rain, snow, and mud. They are designed to throw water away from the road so that the tread will make contact. Otherwise, hydroplaning, where the tire actually floats on water, will take place. To improve traction on all kinds of surfaces, each tread rib has a series of small slits, called *sipes*. When the tire flexes, the sipes open and give gripping action to the road surface.

Belts are stabilizers underneath the tread area. Any tire that is bias-belted or radial has belts. Bias-belted tires have two belts. Radial tires have from two to five belts. The belts are made of rayon, nylon, polyester, fiberglass, steel strands, or a combination of these materials. The belts reinforce the tread and greatly increase its life. They also reduce punctures, prevent bruises, improve tire movement so that squirming action does not create excessive tire wear, and improve traction by keeping the tread ribs on the road surface.

The average size passenger tire weighs about 25 to 30 pounds. It will contain:

- 11 pounds of synthetic and natural rubbers
- 1 pound of steel in the bead
- 2½ pounds of cord fabric
- 2½ pounds of petroleum oils
- 6 pounds of carbon black
- Sulfur, antioxidants, and other chemicals

A tire-building machine is a drum about 2 feet long and the same diameter as the wheel size that the tire is made to fit. After the beads are placed, the drum rotates and the liner is wrapped around the drum. The fabric is put on next, ply by ply, followed by the belts, tread, and sidewall rubber.

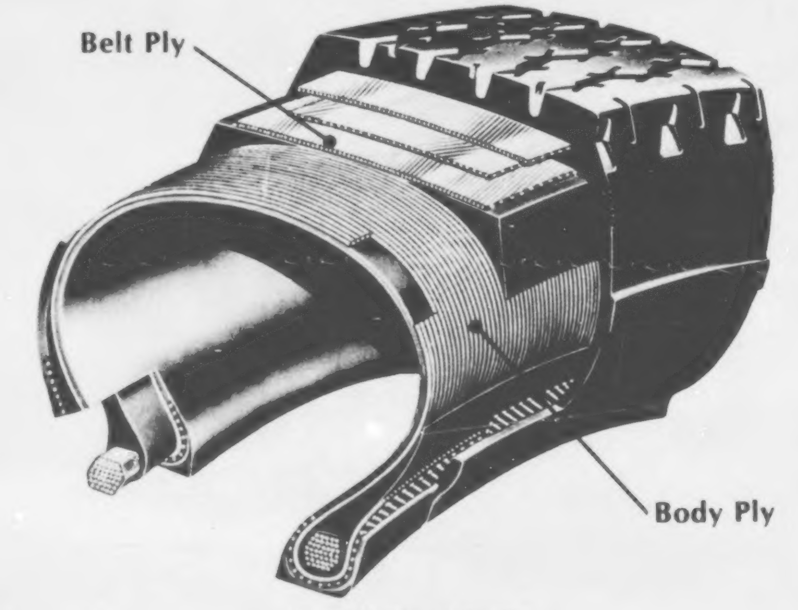


Fig. 15-2. Tire construction

The tire at this stage resembles a barrel. It is removed from the drum and placed inside a mold that will give it its doughnut shape. The mold "cooks" the tire into its final tread and sidewall design and shape.

Tire Cords and Strengths

The five major types of tire cords or fabrics are rayon, nylon, polyester, fiberglass, and steel. A new synthetic fiber, Aramid, is now being used in some makes. It is said to be much stronger than steel, but lighter. Tire cords are used for both the sidewall plies and the belts under the tread. The cord is tightly woven into a flat fabric sheet, then impregnated with rubber. The number of plies used determines the flexibility and strength of the tire. Generally, the cords must have these qualities: (1) great tensile strength, (2) resistance to stretching when hot, (3) flexibility, (4) resistance to flattening or spotting when cold, (5) ability to hold together at high speed, and (6) resistance to cuts and bruises. Table 15.1 compares these qualities of the five cords or fabrics.

Tire Construction Types

There are three basic tire construction types. This means the way in which the plies of fabric are placed inside the tire. The three types are bias-ply, bias-belted, and radial-ply.

Bias-ply is the oldest and original kind of tire construction. In this kind, the plies of cord fabric are made to run on the bias—diagonally around the tire—at about a 35° angle from one bead to the opposite bead. If a tire had four plies, the first layer ran in one direction, and the next one ran in the opposite direction. Plies three and four also ran in alternating directions. Bias-ply tires are strong but have the major disadvantage of wiggle or squirm when running at highway speeds. The bias construction does not hold the tread flat and firm against the road surface.

Bias-belted is an improvement over

Table 15.1

	Rayon	Nylon	Polyester	Fiberglass	Steel
Tensile strength	70%-80% as strong as nylon	very strong	90%-95% as strong as nylon	strongest	comparable to fiberglass
Stretch resistance	very good	poor	very good	excellent	excellent
Flexibility	good	excellent	excellent	poor	fair
Flat-spotting	resistant	poor	resistant	resistant	resistant
High-speed performance	good	excellent	very good	good	good
Cut/bruise resistance	good	excellent	good	excellent	excellent

bias-ply. The same bias-plies of fabric were retained for the sidewalls, but two or more belts of fabric were added between the fabric plies and tread area. The belt fabric is more rigid than the sidewall cord fabric plies because it does not have to have as much flexibility. The addition of the belts gives stability to the tread to reduce squirm and wiggle and to add puncture and bruise resistance.

Radial-ply is a departure from both types, yet keeps the same basic construction design of the bias-belted type. In a bias-ply, the cords in the fabric run at a 35° angle from bead to bead. In radial-ply design, the cords run radially around the tire, or at a 90° angle from bead to bead. Like the bias-belted tire, the radial-ply also has two or more belts under the tread. Radial-ply has the advantage of excellent mileage and good traction, particularly on curves and cornering. The combination of radial design and belts almost eliminates squirm and wiggle of the tread. The biggest dis-

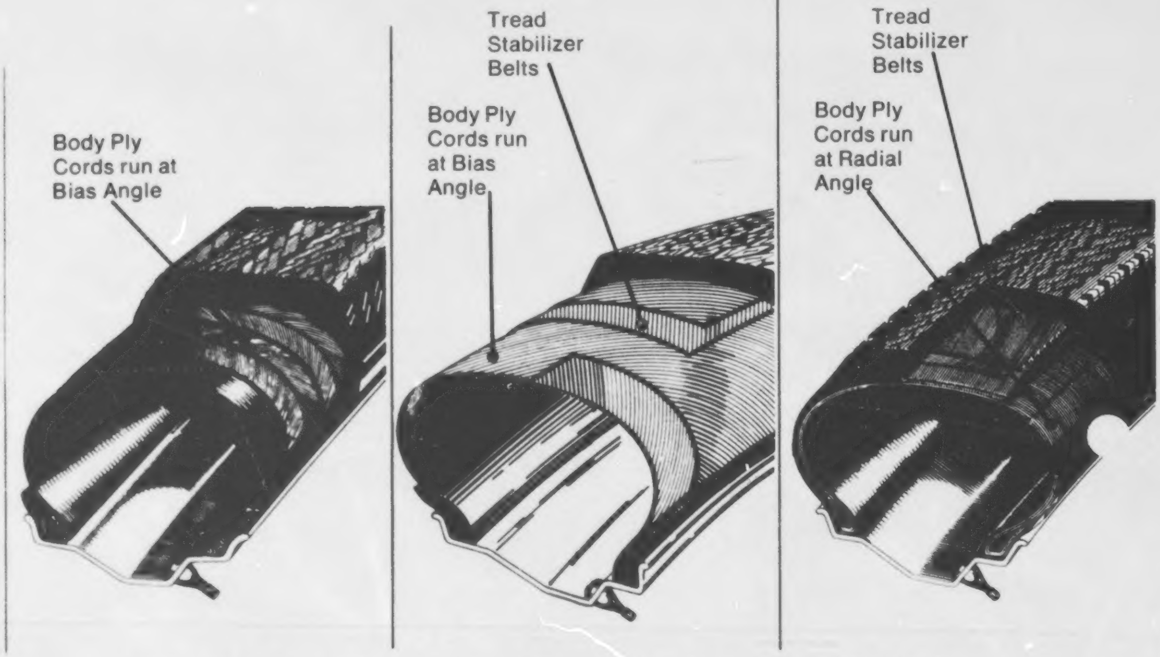


Fig. 15-3. Three types of tire construction (left to right): bias-ply, bias-belted, and radial-ply

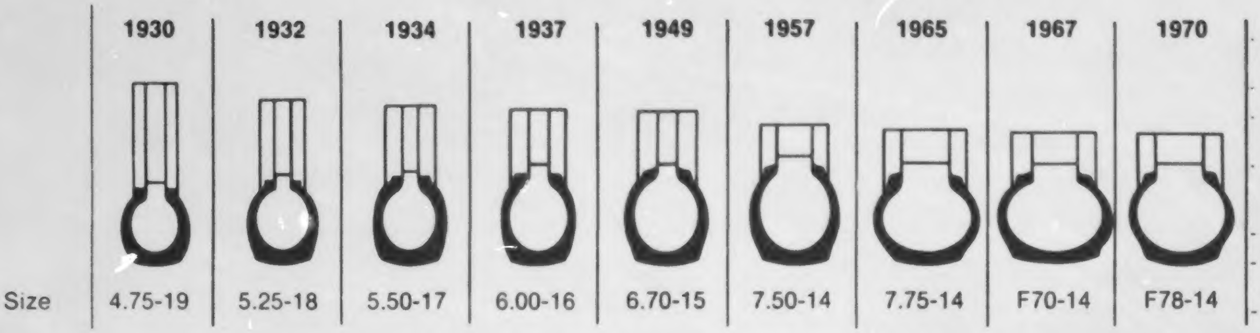


Fig. 15-4. Evolution of the automobile tire, 1930–1970

advantage is a harsh ride at speeds below 40 miles per hour.

Tire Shapes and Sizes

The evolution of the automobile tire has been remarkable over a period of fifty years. Not only have the materials in the tire been consistently improved, but the shapes and sizes of tires have undergone tremendous changes. The general tendency has been for tires to get wider, but with a decreasing amount of air pressure. A look at figure 15-4 shows the evolution from 1930 to 1970. The only major addition to this evolution since 1970 is the change to metric sizing.

Tire Series

In tire language, a *series is the profile or aspect ratio of a tire.* Another way of stating it is that a series refers to the ratio of the section height of a tire to its width. In figure 15-5, you see that *A* measures the height while *B* measures the width at the middle of the sidewall. Width does not measure across the tread, as many tend to think. In figure 15-5, the height of the tire is 78 percent of the width, so it is referred to as the *78 series.*

The first wide series of tires came out in 1965 and is referred to as the *conventional series.* The most popular size of passenger tire was 7.75-14. These numbers in tire sizing mean this:

- *7.75* means the tire is 7.75 inches wide from sidewall to sidewall.
- *14* means the tire fits a 14-inch-diameter wheel.

In 1967, the tire industry produced a wider, fatter tire and developed the series nomenclature—method of naming—to more fully describe the tire size (see fig. 15-6). This was the *70 series.* For example, a tire sized F70-14 meant this:

- *F* refers to the load-carrying ability or capacity at various air pressures.
- *70* stands for the series where the height is 70 percent of the width.
- *14* means the tire fits a 14-inch-diameter wheel.

In 1970, the industry introduced the 78 series, which is described above. It was a compromise between the earlier conventional series and the later wide oval series, which was a little too wide for its height.

The 78 series was further narrowed into the new *82 series,* and the older F78-14 became the newer F82-14. This means that the height is 82 percent of the width. Since that time, a number of changes have been made in tire sizing.

The series designations up through 1970 were designed for bias-ply tires. The lower the series, the wider the tire.

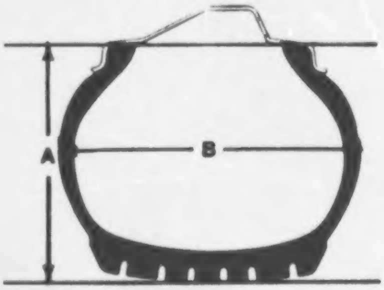


Fig. 15-5. Tire series is measured as the profile aspect ratio. In this series, the height (A) is 78 percent of the width (B). It is a 78 series.

Extremely low-profile tires are a 50 series. The newer radial-ply tires are low profile, but have a different sizing system.

The load range or capacity of a tire has also increased. After the F series came G, H, and J prefixes. The *H* and *J* are designed for larger, heavier automobiles.

When radial-ply tires came onto the market, a new series began. Radial-ply tires have an *R* after the series number, such as 185R-14. Here, the *185* means a width of 185 millimeters. But some manufacturers kept the older series designation and simply added an R to the original sizing. In this case, an FR70-14 is the same size as a 185R-14. The major difference is that some began using metric measurement while others kept the older aspect ratio in sizing.

The newest tire sizing is metric. It is an international sizing method that has come about because of the influx of foreign cars into this country. Nearly all Japanese, German, French, Italian, Swedish, and other foreign makes use a metric size system. A tire size in this system would be P 155/80 D 13, for example. Here is what each part of the new metric sizing means:

- *P* stands for passenger tire.
- *155* means the sidewall width in millimeters.
- *80* is the tire aspect ratio, or the height is 80 percent of the width.
- *D* means bias-ply construction; other letters are *R* for radial, and *B* for bias-belted.
- *13* means the tire fits a 13-inch-diameter wheel.

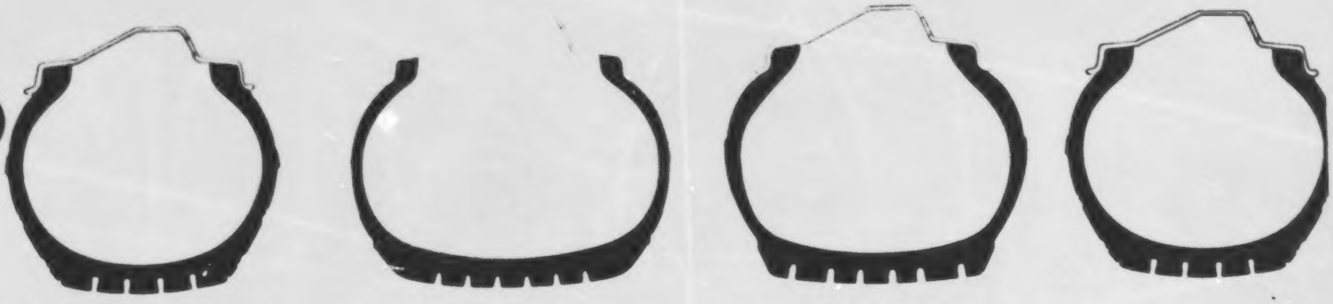


Fig. 15-6. Four popular tire series (left to right): conventional, 70 series, 78 series, and 82 series

Load Range and Ply Ratings

The tire sidewall has molded into it a set of numbers and other data on the load range that a tire can carry at various air pressures. Formerly, a tire's strength was rated by the number of plies. The more plies it had, the stronger the tire. But this became too confusing and was not an accurate rating. Generally, the load range uses a lettering system that corresponds to the number of plies: *A* means two plies, and *L* means twenty plies.

Up near the bead of the tire you will find the load range information. It may read in this fashion:

Load Range B
Max. Load, 1620 lbs.
at 32 psi Max Press.

Load Range *B* means four plies. The tire will support a maximum load of 1,620 pounds when the air pressure is at 32 pounds per square inch. This does not mean that the tire should have a normal air pressure of 32 psi, or that it should always be loaded with 1,620 pounds. That simply means the tire has been rated to carry that maximum load at that maximum air pressure.

Load range *C* tires have six plies and are rated to carry 36 psi maximum. Load range *D* tires have eight plies and are rated to carry 40 psi maximum. Tires above *D* load range are generally truck tires that are designed to carry very heavy loads at higher air pressures.

Other Tire Data

The tire maker, tire name, and DOT number are usually found on the sidewall on the inside surface (see fig. 15-7). The DOT number means that the tire conforms to the Department of Transportation's standards for that particular size, weight, and number of plies. The numbers following the DOT signify the code number of the manufacturer.

Every tire must also be identified as either *tubeless* or *tube-type*. If the tire is of radial-ply construction, it must appear on the tire as *radial*. If the tire is a *retread*, the letter *R* must appear by the DOT number. This should not be confused with the letter *R* that appears in the tire size.

Some tires are designed for special uses, and this information must appear on the sidewall. For example, a truck tire may say that it is "Regroovable," meaning that the tread depth is sufficient for regrooving. Other labels may say, "For Racing Only," "For Agriculture Use Only—Maximum Speed 20 MPH," "For Nonhighway Use Only," or "Unsafe for Highway Use."

Tire Stress

The automobile tire is a remarkable product in both technology and price when you consider what it must go through. No other part of the automobile takes as much stress and strain as do the tires. Consider these facts:

- The average medium-sized passenger car weighs about 4,000 pounds empty.
- Each tire is carrying a constant weight of at least 1,000 pounds all of the time and up to 1,500 pounds with passengers and luggage. If the car is towing a trailer, even more weight is added on each tire. In addition to weight, the tire is being constantly flexed with each revolution because all road surfaces are uneven.
- In high-speed driving, the rapid turning of the tire is constantly throwing it out of round as it turns and as it carries the weight.
- The tire is subjected to high heat from the friction. Heat increases the air pressure inside the tire.
- The tire is pounded by rocks, holes, bumps, and every other kind of obstruction found on roads, streets, and highways.
- The tire is scuffed against curbs that press in the sidewalls, and it must jump curbs and pound into chuckholes without losing its traction on the surface.
- The tire must hold the road and corner well when the road is wet, and give traction on ice and snow. It must withstand all extremes of weather without losing its flexibility and traction.

When tires are designed and tested, they must perform under **stress tests** of three kinds—contraction, expansion, and normal stress. Each time the tire makes a complete turn, it goes through these three cycles (see fig. 15-8).

In the *contraction cycle*, that section of the tire in contact with the road surface makes a footprint with the tread design. The weight on the tire is greatest at this point, so it pulls the cords in the plies in opposite directions and squeezes the ribs in the tread together.

As the tire rotates, the section of the tread that has just left the road surfa

Brand:
Mobil

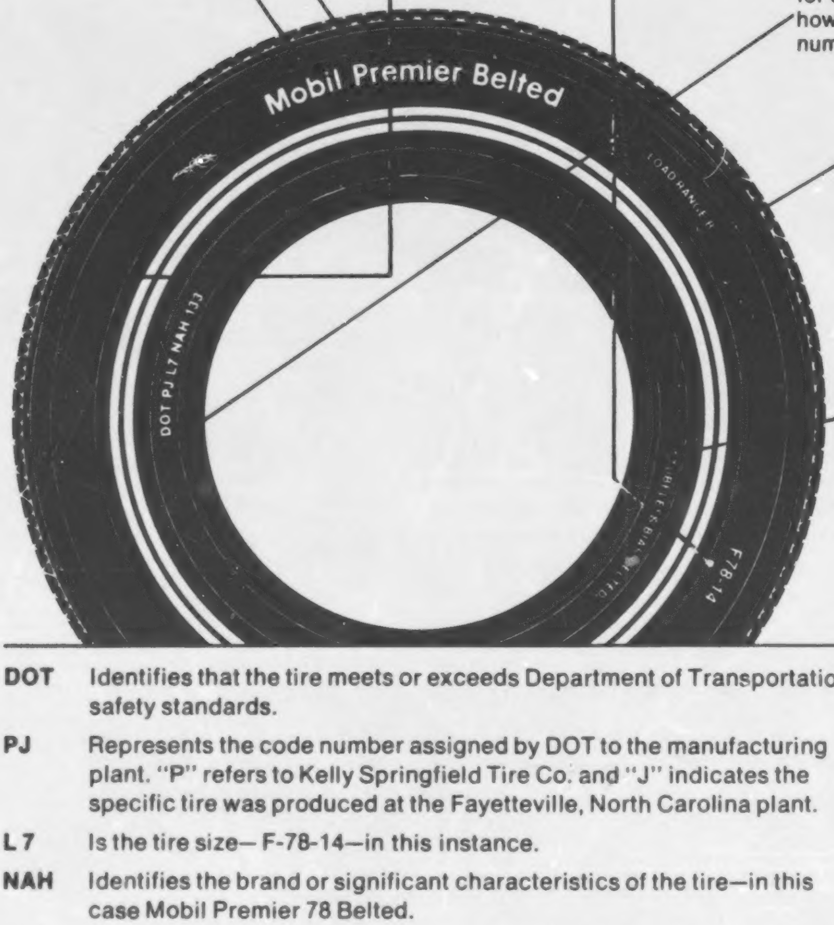
Name:
Premier Belted

Ply Material:
Tread—4 plies (2 plies Polyester cord, 2 plies Fiberglass cord).
Sidewall—2 plies Polyester cord.

Size:
F78-14
F—indicates load-carrying capacity at specific inflations.
78—represents the approximate ratio of section height to tire width.
14—is the wheel diameter.

Serial Numbers:
All tires manufactured after May 22, 1971 carry a new type serial number which identifies the manufacturing plant, the tire size and type, and the week of manufacture.

This serial number appears on the sidewall of the tire near the rim of the wheel. (See below for explanation as to how to read serial number)



Load Range:
Identifies tire load and inflation pressure capacity.

Construction Type:
Tubeless Bias-Belted.

DOT	Identifies that the tire meets or exceeds Department of Transportation safety standards.
PJ	Represents the code number assigned by DOT to the manufacturing plant. "P" refers to Kelly Springfield Tire Co. and "J" indicates the specific tire was produced at the Fayetteville, North Carolina plant.
L 7	Is the tire size— F-78-14—in this instance.
NAH	Identifies the brand or significant characteristics of the tire—in this case Mobil Premier 78 Belted.
133	The last three numbers designate the week and year the tire was manufactured. 13 means the 13th week and 3 indicates 1973.

Fig. 15-7. Important data are found on tire sidewalls. (Courtesy Mobil Oil Cor

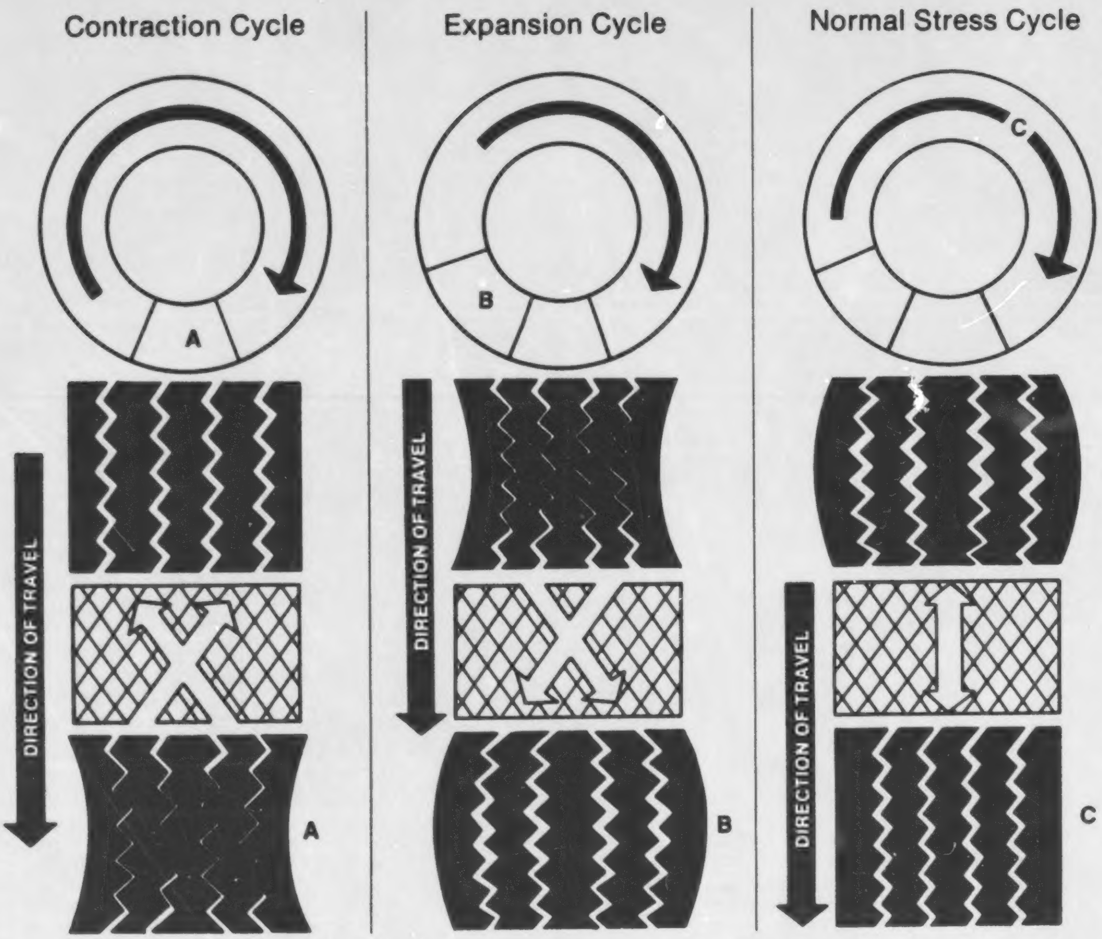


Fig. 15-8. Tire stress during one revolution. (Courtesy Mobil Oil Corp.)

is in its *expansion cycle*. The cords now reverse and pull in the opposite directions, forcing the tread patterns to expand, and pulling the ribs apart.

As the section nears the top and comes around on the opposite side of the revolution, it is near *normal*. The plies relax, as do the tread ribs.

In the bias-ply tire, the contraction cycle squeezes the tread together when each ply pulls in opposing directions. The tread then expands as the cord body relaxes. This is the squirm and wiggle that reduces tire wear. The tire is literally rubbing itself to death against the road's surface.

In the bias-belted tire, the belts between the plies and tread greatly reduce the pulling action in the contraction and expansion cycles. Although there is some squeezing, it is not as much as in bias-ply construction. That means great improved mileage and traction.

In the radial-ply design, the 90° angle of plies almost eliminates the contraction and expansion of ribs and cord fabric. The belts give additional stability to the tread, particularly at high speeds, thus improving mileage and traction even more.

Questions

1. What is the purpose of the steel bead in a tire?
2. What are plies, and how are they used in tire construction?
3. What is the purpose of belts under the tread area?
4. What are the basic differences between bias-ply, bias-belted, and radial-ply construction in tires?
5. What is meant by tire aspect ratio in sizing?
6. Tell what each of these sizes means: (1) 190R-15, (2) F78-14, and (3) P 150/75 B 13.
7. What is the *load range* on a tire?
8. Name three kinds of stress tests that a tire must pass.

Project

From your training station's stock of tires, select one passenger car tire. Record all of the sidewall markings on the tire, including size, DOT number, load range, and all other markings. Tell what each letter and number means, including the manufacturer's name and DOT code number. If you are not certain about some data or figures, consult the catalog sheets or ask your training sponsor.

16

Selling Tires

Objectives: After completing this assignment, you will be able to—

1. describe five common signs of tire damage that call for replacement;
2. explain the best method of telling a customer of replacement tire needs;
3. discuss how to determine a customer's needs;
4. describe features and benefits of tires that should be called to the customer's attention; and
5. state the two main reasons why closing a sale should be planned from the start.

Automobile tires are sold in many locations and types of businesses. The two largest distributors are service stations and the retail tire and automobile accessory stores. Tires are also sold in department stores, in service centers, and by mass merchandisers. The method you use to sell tires will depend largely on where you are selling them.

Replacement tires are a *$5 billion* market each year. That makes tire selling a very important competency. You can sell tires easily if (1) you know your product, (2) you know where and how to look for tire needs, and (3) you know how to appeal to the customer's needs.

Five-Step Approach

There is one main fact to remember in learning to sell tires: *60 percent of all automobiles being driven today need at least one replacement tire.* That gives you a tremendous number of potential customers. The reason why six out of ten automobile owners have *failed* to buy a tire is because (1) they do not know they need one replaced and (2) no one has called it to their attention. If you are in a tire and accessory retail store or in a retail distributorship other than a service station, you will not see the customer's automobile. In the service station, the car is visible on the driveway and may be easily inspected. In other types of retail stores, you must wait until the customer comes in. You may or may not have an opportunity to observe the vehicle.

Observe the Need

In the service station, you have the opportunity to observe each car driven into your pump island area or service bay. There are signs to look for as you walk around the automobile. These are the most common and obvious ones.

If a car is two years old, you can assume it has the original tires on it, and they are likely to be showing signs of wear. On all tires manufactured today, the maker must mold into the tread design what are known as *wear indicators.* When the tread wears to a depth of 2/32 inch, there will be a straight line across the tread area. This is the visual indicator that the tread is too worn to be considered safe. When the tire is this thin, there is a 90 percent certainty that it will blow out or puncture within a short time. The customer may not be aware of the wear indicators (fig. 16-1).

Underinflation and *overinflation* are common, and the results are obvious on the tire treads. When a tire is overinflated, it rounds out the tread area so it does not make a flat, full contact with the road (see fig. 16-2). The center of the tread wears down, leaving the outer tread looking normal. The tire is in danger of blowout or puncture within a short time.

Underinflation is the most common occurrence, particularly with low profile and radial tires. The tires look low most of the time when inflated to the normal pressure. Customers get accustomed to seeing tires with a low profile, so they seldom bother to check and air up. As a result, most tires on vehicles today are underinflated. This causes the center of the tread to bow inward, letting the outside tread wear down. Again, the tire is in danger of failure within a short time.

Shoulder and tread separation is easily seen, particularly on the outer surface. You will observe a separation line between the sidewall and the tread, or you will see large pieces of rubber missing and the fabric cord showing through. This tire is extremely dangerous and should not be driven. It will likely blow out at any time. Severe shocks and road bruises from hitting chuckholes, jumping curbs, and running over large stones cause this kind of tire failure. Tubeless tires are more subject to tread separation than other types. Retreaded tires usually fail in this way. High heat and excessive highway speeds for long periods of time will also cause this kind of tire failure.

Faulty wheel alignment causes the tread to cup and dish out small hollow pockets of tread. The edges of the tread ribs will look very sharp, and the wear will be uneven (see fig. 16-3). When one side of the tread is worn and the other is normal, it is a sign of faulty wheel alignment. Toe-in, toe-out, caster, and camber adjustments need to be made. If caught early enough, the tire can be saved by rotation to another wheel and by correcting the wheel alignment. If the tire is too worn, it will probably fail within a short time and should be replaced.

A *flat tire* that has been brought in for service may prove to be in need of replacement. A tire can look good on the outside, yet have a severe cut, bruise, or crack on the inside that cannot be adequately repaired. Some punctures from large nails and other objects cannot be satisfactorily repaired. Radial tires are difficult to repair, especially those with sidewall punctures and breaks. A patch may hold for a short while, but the tire will fail when it gets hot or is run at highway speeds.

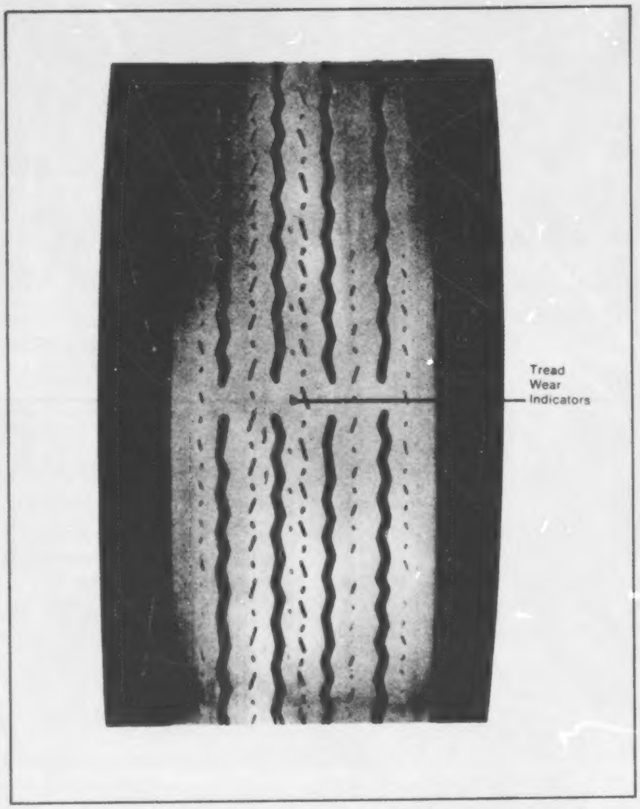
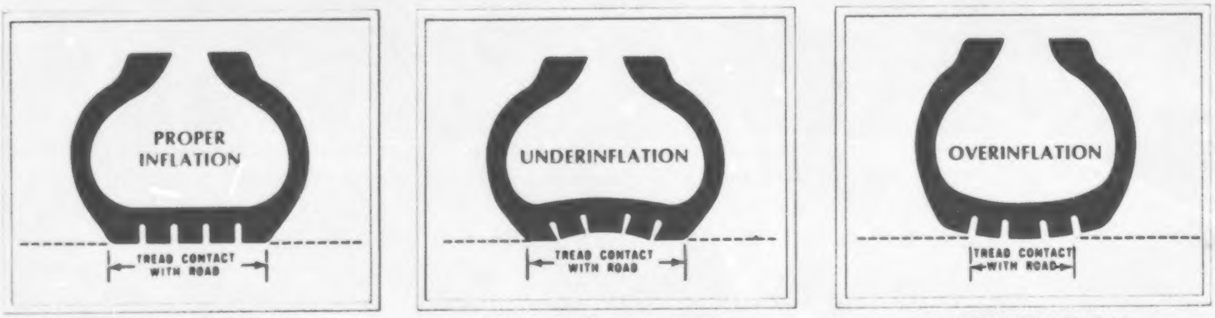


Fig. 16-1. Built-in tread wear indicators tell when a tire is unsafe

Show the Customer the Need

You cannot expect your customer to know his or her tire needs. Most motorists do not inspect their automobiles, even periodically. Few inspect them on a regular basis. Many will drive on dangerous tires, not knowing that the tires are candidates for failure. You are doing your customer a real service by pointing out suspicious places or areas where tire failure is likely to occur. Unless you do, the need will never be known until it is too late.

Many customers are under the impression that steel-belted radial tires are punctureproof and never need inspecting. This is a common misconception. The truth is that the deeper tread designs on today's tires easily pick up nails and sharp stones that work their way into the tire. Steel belts are *not* punctureproof.



PROPER INFLATION
The correct profile for full contact with the road.

UNDERINFLATION
Causes abnormal tire deflection, which builds up excessive heat, running the risk of failure. It also causes irregular wear.

OVERINFLATION
Causes tires to run hard and makes them more vulnerable to impact and other road hazard damage. It also causes irregular wear.

Figure 16-2

Show and tell is the best axiom for selling tires. Simply tell the customer that you have observed a faulty tire, and ask to show it to him or her.

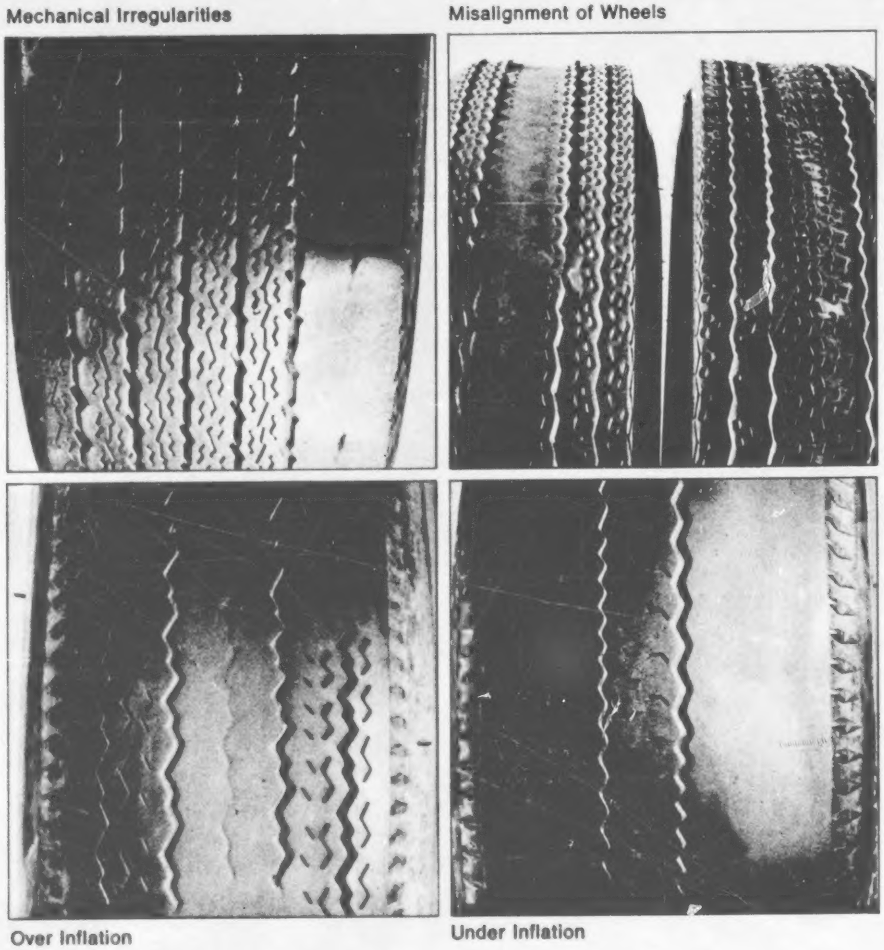
- "Would you mind getting out and letting me show you your back right tire?"
- "Are you aware that your left front tire has a shoulder separation? Come, let me show you."
- "Do you check your air pressure regularly? You are driving your tires underinflated, and they are showing excessive wear. Let me show you what I mean."
- "Do you know how many miles you have on these tires? The wear indicators are showing on two of them. Let me show you what I mean."
- "You have a break on the sidewall of one tire here. You had better let me replace it for you before you have a blowout. I have chalked it so you can see for yourself."

Find Out the Replacement Need

Once you have shown the customer the need, you should then find out what kind of replacement tire to recommend. To do so with the customer's best interests in mind, you need to ask some questions.

1. Find out the customer's driving habits. Is the car driven mostly in town? On the highway a lot? On city streets or on rural roads? At moderate speeds, or at highway speeds? About how many miles a year?
2. Find the customer's greatest area of concern. Is the customer more concerned with safety, economy, appearances, convenient terms, or ride and comfort?
3. Find out if any unusual uses of the vehicle—such as towing a trailer, travel into outdoor areas, off-road terrain, or hauling heavy loads—would require additional tire values.

A few questions will usually establish the kind of tire to show and recommend as a replacement. If economy is the customer's first concern, then recommend your best tire value, and be sure to stress easy terms and payment plans if available. If the customer's first concern is safety and long mileage, then show your best tire, stressing long mileage and rugged construction features. For appearance factors, stress white sidewalls, raised lettering on sidewalls, and other sports features. Show the best tire value that



Mechanical Irregularities

Misalignment of Wheels

Over Inflation

Under Inflation

Fig. 16-3. External signs that show the need for tire replacement

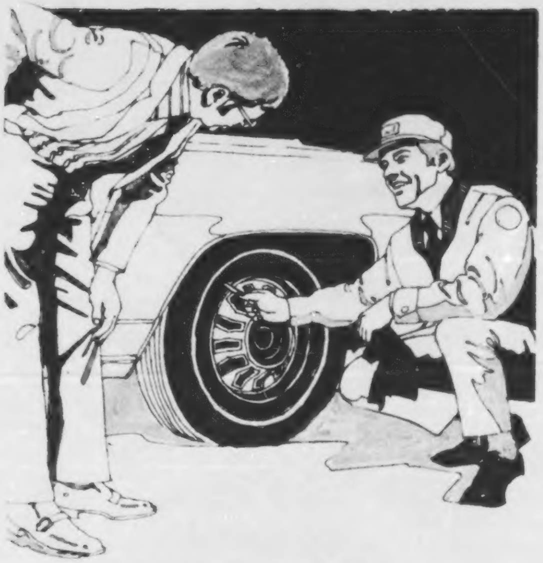


Fig. 16-4. Show the customer the need.

you have for an individual customer's needs.

It is recommended that you *always show your best-quality tire first.* Never assume that the customer only wants the cheapest tire he or she can get by with. Even for economy-minded customers, the best quality is usually the lowest cost in the long run. Stress values and economy when priced by expected mileage. When you show your best, you know you can feel good about the customer's selecting it. If the customer cannot or will not consider the very best, then you have room to come to your middle line and still be able to recommend a good tire value. Your low-end tires should be reserved only for those to whom the lowest possible price is all they will consider.

Show Features and Sell Benefits

The reason for studying tire construction is to be able to show and explain the hidden features and benefits of a tire.

- Show why a radial tire is a superior tire because of its construction design and belts. Explain why it will give longer mileage and have superior road-gripping ability and control on curves and corners. Sell the benefits of owning radials—long wear, safety, economy over the years, better handling and ride, and improved gas mileage. Do not oversell improved gasoline mileage because this is a questionable factor since individual driving habits vary so much. For some kinds of drivers, radials will give better gas mileage.
- Show and explain why a bias-belted tire is superior to a regular bias-ply tire. It has superior ride and comfort and greater resistance to punctures and road bruises. It is economical because it costs less than radials, but gives improved mileage and ride. It will wear longer because the belts hold the tread firmly.
- For minimum needs, recommend the bias-ply tire. It is a good tire value for mostly in-city driving and short trips. It gives good ride and safety, and, of course, it costs less. If the car will be sold or traded within a year, the bias-ply is probably the best value.

Point out the features. Stress the benefits of those features. A belted tire means nothing to the average motorist. You have to explain what the belt is, where it's located, and how it makes the tire better. You should always stress safety, comfort, economy, and convenience. These are what the customer is most interested in. Stress the benefits of owning radial tires. You can't expect the average motorist to know what a radial tire is and how it benefits the car owner unless you tell and explain.

Close the Sale

In the practical selling approach, regardless of the product, you plan to close a sale even before you begin the selling process. Why? There are two big reasons.

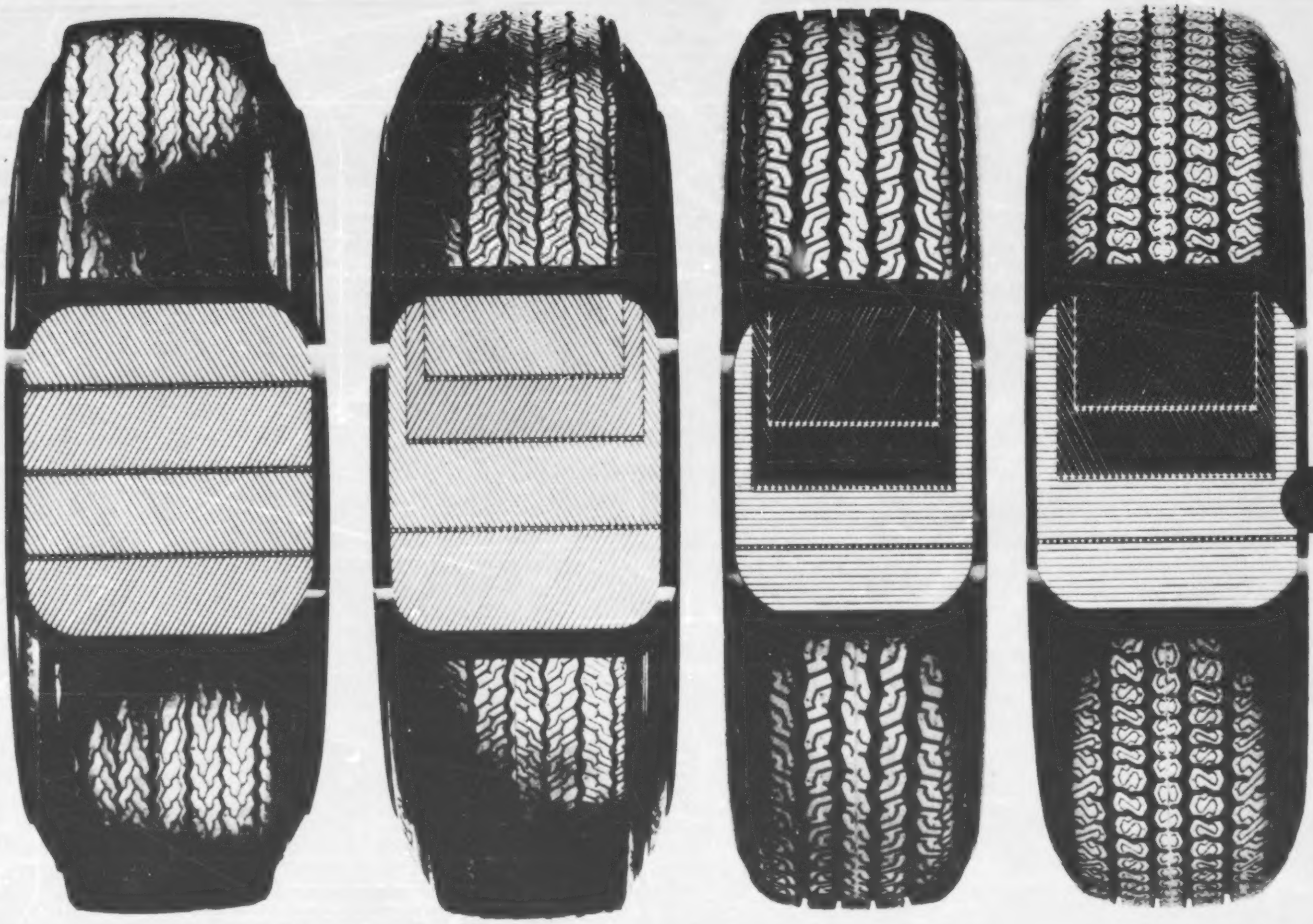
1. *Most sales are lost at this step.* The salesperson does not ask for the order or is hesitant. Too many people tell all the facts about the product, but leave the final decision to the customer. Customers do not often close the sale unless they are specifically asked. The longer you let a customer study about it or mull it over, the less chance that a buying decision will be made. When given time to think, these are some of the thoughts that go through the customer's mind.

- "Two hundred dollars is just too much to pay right now."
- "Maybe I can get by for another month or two before I have to buy more tires."
- "This is totally unexpected. I just don't know how I can manage this now."
- "I'll shop around. I'm sure I can buy somewhere else and get some cheaper tires."
- "I'm sure there are several thousand miles left in those tires. No need to buy right now."
- "Maybe after the first of the year will be a better time to buy."

Customers left to their own decision making will usually reason why they should delay a purchase rather than make one now. You must give them reasons—good, solid reasons—for buying now. Stress safety. Stress easy payment terms. Stress convenience—riding on safe tires without worrying about flats or blowouts.

2. *If you don't plan to close, you never will.* When you have shown the features, stressed the benefits, and recommended the best tire for the customer's need, then ask for the order.

- "May I have these put on now? We can have the car ready in an hour."
- "Will this be cash, or would you like to put these on your charge card?"



Four body plies crisscross alternately in opposite directions.

All plies made of same cord, usually nylon or polyester.

Averages from 20,000 to 25,000 miles wear.

Union Three Star features this 4-ply construction.

Two body plies of polyester cord crisscross in opposite directions.

Two belt plies of fiberglass laid crisscross under tread.

Offers a smooth ride and great traction.

Union Sports Oval uses this [illegible] of construction.

Average wear 24,000 to [illegible]00 miles.

Two radial plies of polyester cord.

Two belt plies of 330's glass laid at angles to radial plies.

A radial tire at an affordable price.

Complete range of sizes for all cars.

Averages 30,000 miles of wear.

Two body plies of polyester. Cords run *radially* at 90 degree angle to direction of travel.

Two belts of steel cord, laid at slight angles under tread.

Premium tire, offering entirely new driving experience.

Resistance-free rolling delivers better gasoline mileage than bias-belted construction.

Averages 35,000 to 40,00[illegible] miles of wear.

Fig. 16-5. Recommend the right tire for the customer's needs.

- "Would you like these on our new extended payment plan?"
- "May I have them check the front-end alignment while we change the tires?"
- "I'm sure you want these balanced on the wheel when we mount them."
- "We'll put in new valve stems and balance the tires, too."
- "You are going to notice a big difference in the feel and drive of these new radials."
- "You made a wise decision. I feel sure one or more of these tires would have gone bad within a few more weeks."
- "You can take your next trip with complete assurance that you've got the best tires made."

Overcoming Objections

In retail stores, your customers will most often come inside. They may have come in because of a sale event or special price being advertised. They may have come to purchase some other product. They may be inside because their car is being serviced in the service bay area. Whatever the reason, your customer is looking at tires on display. In this situation, you use a merchandise approach.

In a *merchandise approach*, your opening remark to a customer is a statement—fact, feature, or benefit—about the particular tire at which he or she is looking. It gives you an opportunity to discover the customer's need and determine the interest in tires.

As you make your selling presentation, you often hear customers voice objections or excuses of one kind or another. Many objections are simply excuses to put off a decision to buy. Regardless, your selling job is to answer objections and give good reasons for buying now.

Objections to price are most common. To overcome or answer these, you should point out value, safety, and long mileage. It is good to ask the customer how much are personal and family safety worth. Stress that the difference in cost per tire is very little when it is measured in total mileage given. Point out that the difference saved in a few dollars could well mean replacement within two years, whereas the better tire would last at least a third longer. The price question is also easily settled by stressing the convenient payment plans — deferred payments, monthly payments, and extended terms.

"I'm just looking" is the most common excuse to put off a buying decision. But don't let it be your cue to leave the customer alone. "Just looking" means that the customer has some interest, even though the need may not be immediate. Be polite and tell the customer that you are glad he or she came in to look. Proceed with your sales presentation, and stress the values and benefits of a particular tire. Give reasons why the customer ought to buy now.

Other excuses are these: "I'll have to wait until the first of the month (or payday)"; "I'll talk it over with my wife (or husband)"; "I'll be back next week." These are other ways that the customer has of avoiding a buying decision. Be polite, but don't let these excuses prevent you from going ahead with your sales presentation.

Sell the Right Tires

In the interests of safety, value, and performance, there are certain things you should know and observe in selling the right kind of tires to customers. It is best if all four tires are of the same tread pattern, kind, size, and type. You should recommend to the customer that tires at least be purchased in sets of two or four. The same size tire and tread pattern should be on both wheels of the same axle. Bias-belted tires can be used with bias-ply tires, but two tires of the same type should be opposite each other. You should never mix radial-ply tires with bias-ply or bias-belted tires. If two radials are sold and are mixed, the radials should go on the back wheels only. When snow tires are installed, they should go on the rear wheels, and bias-ply snow tires should never be mixed with radial tires on the front wheels.

You should never install tires on the customer's car without first checking to make sure the tires specified will fit the wheels and rims. Tire width must match rim width. Otherwise, beads will become distorted, air pressure will decrease, and tread life will be greatly reduced. More serious to the customer, the tire may come off the rim completely when turning a sharp corner. Rims on passenger cars are made in 4½-inch to 7-inch widths. However, several different sizes of tires will fit a standard-width rim. For example, a 5½-inch rim will take all E, F, and G78 series tires. An F78 series tire will fit a 5-, 5½-, and 6-inch rim.

In selling special-purpose tires, you must make sure that the outer circumference of the tire has enough clearance in the wheel well, particularly on the front wheels. Extra-wide width treads and large tires on off-road vehicles need to have clearance for the many bumps and up-and-down movement they will have. On smaller-than-normal tires and wheels, make sure the tire will carry the necessary weight, and make sure it will not drop the car too low to the ground.

Questions

1. What is the potential market for replacement tires each year and every day?
2. Name and briefly describe five tire conditions that suggest a replacement need.
3. What is the best method of telling a customer of replacement tire needs?
4. What are three main kinds of questions to ask to determine the customer's needs in replacement tires?
5. When showing several qualities of tires, where is it best to begin in selling?
6. Name the benefits of a radial-ply, bias-ply, and bias-belted tire.
7. Name the two main reasons why closing a sale should be planned from the start.
8. How are the customer's objections to price, and indecision and excuses, best handled?

Project

From your training station's stock of tires, select one bias-ply, one bias-belted, and one radial tire. For each tire, list the retail price, the trade-in price (if any), and the specific features for each tire. Beside each feature, list the benefit that you would sell to the customer. Use the form shown as an example.

XXX Tires

Training Station Name ____________________
Tire Brand Name ____________________

Tire Type	Feature	Benefit
XXX Bias-Ply	Attractive white stripe	Improves car appearance
	Four-ply rayon cord	Comfortable, smooth ride at all speeds
XXX Bias-Belted		

Objectives: After completing this assignment, you will be able to—

1. describe the main function of shock absorbers;
2. tell how a shock absorber works;
3. describe the construction of a shock absorber;
4. name six advantages of rear overload shock absorbers;
5. explain three ways to check a car for weak or worn shock absorbers;
6. tell how shock absorbers are best sold; and
7. explain the benefits of replacing shock absorbers.

17

Selling Shock Absorbers

When you are making a visual inspection of automobile tires, you may spot one or more that have small cupped or dished areas in the tread. This condition may be caused by improper wheel alignment, but it may also be caused by excessive wheel bounce. Wheel bounce means worn shock absorbers.

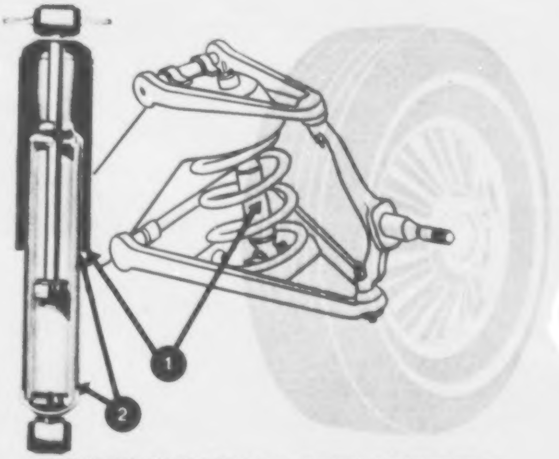
Function of Shock Absorbers

Shock absorbers control the movement of the car springs. They act to dampen (soften) the up-and-down movement of the wheel on rough roads and uneven pavement. When an automobile hits a bump or hole, the wheels rise off the road's surface. There are strong springs that resist the shock, but the springs will continue to bounce unless the shock absorber removes the force.

To maintain complete control during driving and braking, the car's wheels should be in full contact with the road at all times. The shock absorber's main function is to keep all four wheels on the road (fig. 17-1). Shock absorbers resist the motion of the car's wheels and frame. Without shock absorbers, the strong spring action would slap the wheel back on the road. The jar would be transferred to the car's frame and body. Passengers would experience an extremely bumpy, uneven, harsh ride.

How the Shock Absorber Works

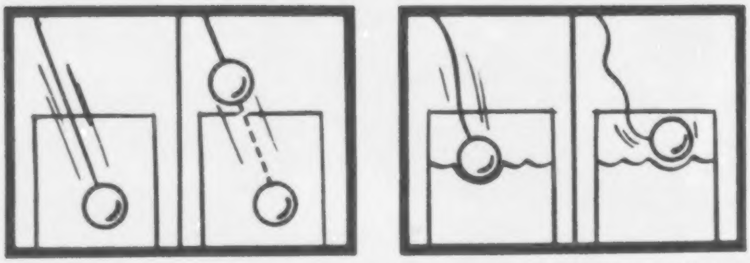
One end of the shock absorber is attached to the frame or chassis of the vehicle, and the other end is attached to the wheel axle. The shock absorber piston is actually two cylinders in one housing. It is called a two-tube shock absorber design, and it works by hydraulic action. *Hydraulic* means the use of fluid to move or resist movement. In the shock absorber, oil is used to resist movement. The shock absorber is a dual-movement device because it must adjust itself for low-speed and high-speed conditions. When the car is moving slowly, the bumps are smoother and easier. The valves in the piston open freely, letting the oil flow from the piston to the reserve chamber. But in high-speed driving, the wheels are moving quickly in an up-and-down motion. The valves must keep the fluid in the chamber to resist the shocks. In normal driving,



THE MAIN PURPOSE OF A SHOCK ABSORBER IS TO KEEP THE WHEELS ON THE ROAD!

1. Force of bump is taken up by spring which is controlled by the shock absorber. 2. The resistance of fluid through the shock piston forces the bump action to dissipate within the spring without rebound.

Figure 17-1



A weight on a rubber band dropped into an empty cylinder has a big rebound range.

The same weight dropped into a cylinder filled with fluid meets a resistance and arrests the rebound.

Figure 17-2

the up-and-down movement is about 960 times per minute.

If you are pumping air with an ordinary bicycle pump, you can observe a similar action. When you pump slowly, there is little resistance and the movement is easy. But as you pump faster, the resistance builds quickly, and it is more difficult to make a complete cycle without hard pressure.

If you had a steel ball on a rubber band and dropped it into an empty cylinder, the steel ball would rebound sharply at the end of the drop. However, if you filled the cylinder with oil and dropped the ball, the oil would absorb the weight and let the ball sink slowly to the end of its drop. This is the same principle that a shock absorber uses to control movement (see fig. 17-2).

Construction

The basic design of all double-acting, two-tube, hydraulic shock absorbers is the same for all types used on today's motor vehicles. Look at figure 17-3 to identify the parts. The upper mounts are of three standard types—loop, stud, and bar. The mount is attached to a piston rod that extends into the sealed oil-filled chamber. Nearly all shock absorbers have an outer steel shell that is a dust cover. It extends about halfway down and protects the upper seals from dust, dirt, and water.

The upper end of the oil chamber is sealed with a special oil-resistant neoprene and is held in place by a coil spring. The upper rod is attached to a piston inside the chamber. It has a valve that meters the oil in and out as the piston moves up and down inside the chamber. The bottom end of the chamber has a mounting that attaches to the wheel axle.

All parts must be made of high-strength, heavy-gauge steel to resist breaks from flying stones. The chamber and oil reservoir must be properly sealed to prevent leaks. The piston must be precision-honed and fitted inside the chamber so that no oil can leak around it. The oil itself must be fluid at temperatures ranges from -50°F to +300°F.

The size of the shock absorber and its quality is in the construction. The greater the weight of the vehicle, the larger the shock absorber capacity and chamber must be. A "stiff" shock is generally recommended for new cars, heavy tow loads, and rough terrain.

Rear Overload Shock Absorbers

Suspension systems of automobiles are engineered for total car weight plus one to three passengers. Large heavy vehicles, station wagons, and light trucks used for hauling heavy loads must have stiffer shock absorbers on the rear springs. On long trips, most cars are loaded to capacity in the rear trunk area. For outdoor activities, many vehicles tow boats and small trailers and often drive over rough, uneven ground and bumpy roads. All of these kinds of driving and loading require rear overload shock absorbers (see fig. 17-4). These overload types have several advantages:

1. They act automatically to level the car whether it is loaded or unloaded.
2. They help prevent "bottoming" when the rear passes over bumps, dips, and uneven ground.
3. They maintain the front end of the car on an even keel so the headlights are aimed on the road and not up in the air.
4. They permit easy use of the rearview and sideview mirrors, so drivers do not have to keep readjusting their line of sight.
5. They prevent rear end scraping on driveways, where bumpers and hitches drag and gouge out chunks of concrete or paving material.
6. They increase tire life by forcing some of the rear load up to the front wheels.

If rear springs are already weak from overloading, the overload shock absorbers will *not* correct the condition. They are meant to assist the rear springs in doing their job. The major difference in design is a heavy-duty coil spring that acts as an extra stiffening device to help support excessive weights on the rear axles and wheels.

Why Shock Absorbers Wear Out and Need Replacing

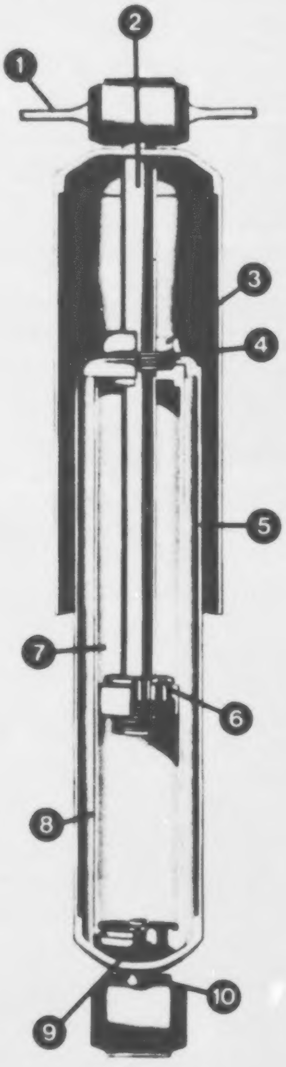
The motorist seldom, if ever, sees the shock absorbers. They can't be seen on most cars without putting the vehicle on a lift and getting underneath. Because they can't be seen, most motorists neglect inspection or checking. When shock absorbers do begin to wear, their change in performance is so gradual that the motorist hardly notices. Over a long period, there is less control during driving and braking and excessive tire wear, and the motorist does not know why.

The average life of a shock absorber is about 20,000 miles. They wear out because the seals can only last so long. When you consider the amount of piston travel in the shock absorber in 20,000 miles, you can understand why the seals eventually give way. Heat also works to destroy the seals, plus

INTERNAL CONSTRUCTION

To understand how a double action, two-tube, hydraulic shock absorber works, we must become familiar with its basic design. One end of the shock absorber is attached to the axle and the other end to the frame of the car. The attachments are known as mounts and there are three basic types—loop, stud, and bar. In a few instances, special mounts are used to accommodate special installations. All rear shock absorbers, and some front shock absorbers, have outside dust tubes to protect the shaft from flying stones and dirt. The outer tube of the shock absorber encloses the reserve chamber and shock absorber fluid and inside the reserve chamber is the working chamber. The valving which permits fluid to flow from the working to reserve chambers and back is at the base of the working chamber. The shock absorber piston is attached to a rod which moves up and down in the working chamber. At the top of the shock absorber there is a rod guide and seal, held in place by a coil spring and covered by a welded steel cap.

A shock absorber damps and controls spring motions by setting up resistance forces when the piston moves and forces fluid through a set of calibrated valves. These resistance forces depend on the frequency and length of the wheel motion. At low speeds, with low axle movement, the fluid has more time to escape the valves, reducing the pressure build-up in the shock absorber. At high speeds, with rapid axle movement, the internal pressure build-up is faster, since the fluid has little time to flow through the valves. In this way, hydraulic shock absorbers automatically adapt to the severity and frequency of the bumps.



Double Action, Larger 1-3/16" Bore Type

DELUXE HEAVY DUTY

1. **RUGGED UPPER MOUNTS** for assured strength and service under toughest driving conditions.
2. **SMOOTH, SUPER-HARDENED ½" DIAMETER SHAFT** means less friction, longer service life.
3. **MULTI-LIP SEAL**—specially compounded for full, 360° shaft wiping to keep fluid in for longer service life.
4. **FOUR-COIL SPRING** with flat top coil gives uniform tension on seal at all temperatures.
5. **TOUGH, HEAVY DUTY WALLS** resist damage from flying stones for longer life.
6. **LARGER PISTON** — Big 1$\frac{3}{16}$" size — with precision valving for smoother ride, maximum car control.
7. **ALL-WEATHER FLUID** assures instant shock action from 50° below to 300° above.
8. **1$\frac{3}{16}$" MICRO-SMOOTH CYLINDER**—Mirror-like finish for perfect piston fit—prevents blow-by, reduces wear and prolongs service life.
9. **SPECIAL RESERVOIR VALVING** measures fluid flow for uniform, smooth ride under all load and road conditions.
10. **TRIPLE-WELDED LOWER MOUNT** — Additional welds provide maximum protection against mount breakage.

COOLER OPERATION reduces stress on internal parts for longer life.

Figure 17-3

FUNCTION AND DESIGN OF A REAR OVERLOAD

Suspension systems of automobiles are engineered on the basis of a carload of one to three passengers. With the increase in size of the average family car, the great popularity of station wagons, and the fact that as many as six to eight passengers may be carried, many cars are constantly overloaded. Trunkloads of baggage and heavy merchandise or samples in either the trunk or the back, further overload the vehicle.

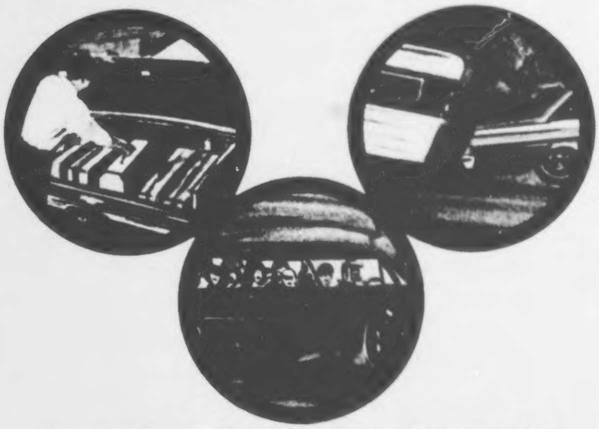
More people are interested in sporting activities than ever before. More house trailers and boats are being towed; more weekend, occasional farmers haul fertilizer and feed; more "do-it-yourselfers" haul building equipment, cement, etc. In all of these instances greatly increased loads are carried in the rear part of the car, changing the center of gravity of the whole vehicle and upsetting the balance of the car.

The answer to these load problems are shock absorbers, engineered for each make and model of car.

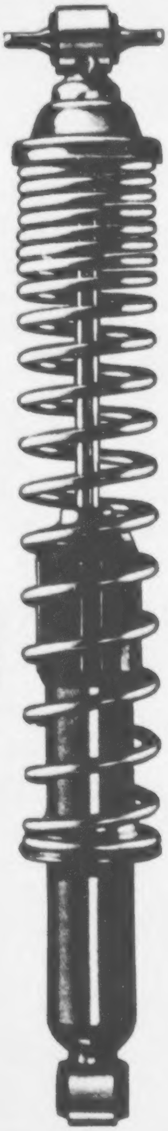
What are advantages of overloads?

1. They automatically level the car for both light and heavy loads.
2. Prevent bottoming.
3. Increase vehicle stability on turns and reduce roll and sway.
4. Keep headlight beams level.
5. Permit normal rear view mirror vision.
6. Prevent rear end scraping on steep driveways.
7. Increase tire life.

Overload type shock absorbers cannot replace worn out or badly sagging springs or springs with broken leaves—overloads are helper units.



Overload type shock absorbers with extra heavy spring-assist help keep the car level when extra weight is added, such as shown above: Heavy luggage in the trunk, passengers, towing boats or house trailers.



Rear Overload Shock Absorber

1. All the outstanding features of the Deluxe Heavy Duty, plus a progressive rate spring. This spring is calibrated and tempered to provide extra lifting power needed in today's heavier cars.
2. Keeps the car stabilized — with one passenger or many, loaded or empty, towing or just cruising. Regular shock absorbers are not built to give this extra load absorbing, extra lifting power.
3. Stainless steel shaft, ½" diameter for extra strength. Big piston, all-weather fluid, heavy tube walls, extra strength mounts and heavy coil springs mean lasting service.
4. Engineered for turnpike or freeway driving—prevents dangerous rear end sag; swaying on curves, and excessive tire wear.

Figure 17-4

overloading and the normal wear-and-tear that most suspension systems go through.

Shock absorbers can also have broken mounts. Loose bushings will cause them to move about, thus lessening their action. If you see oil on the barrel of the shock absorber, it's a good indication the springs and seals have given way.

Inspection of Shock Absorbers

First, check the odometer to see the mileage of the car. Age or mileage is a good factor to go by. Usually, shock absorbers should be replaced every 20,000 to 25,000 miles. Second, look for oil leakage signs that indicate the chamber is losing fluid. Shake each shock absorber to see if it is loose, which indicates a broken mounting or loose bushing material. Third, bounce the car by pushing up and down on the front hood area several times. If the car bounces twice or more, the shock absorbers are weak or deteriorated. Check both front end and rear end for excessive bounce. Fourth, a drive test at about 10 mph, tapping the brake lightly several times to make the front end weave up and down, will let you check for complete control or bounce. A good shock absorber will have a slow, steady ride. A jerky or fairly easy travel indicates a worn-out shock absorber.

With the car on the lift, the lower end of the shock absorber can be disconnected. Push up against the upper end of the piston. If it moves easily, the shock absorber needs replacing. As a last resort, the shock absorber must be completely removed and tested on the bench. The shock absorber should be extended and then compressed. There should be more resistance in extension than in compression.

Selling Shock Absorbers

Usually, few customers ask for replacement shock absorbers. Some will notice the change in ride and handling and will ask to have the shock absorbers checked. Some may come in because of advertised specials. But most customers will only buy replacements if you show them the need, and then sell on the basis of that need.

In a service station, you can use several methods to check the general condition of the automobile for shock absorber wear. As part of the driveway procedure, you will check under the hood and look at the tires as a matter of service routine. Under the hood on many models of automobiles, you can see the upper part of the front control arm and spring assembly. You can take a quick visual check for signs of shock absorber leakage or loose bushings. When checking the tires, look for signs of unusual wear on the tread, like dishing or cupping, or uneven wear spots on the center ribs. If you see these signs, then give the front and rear ends the bounce test.

If visual signs indicate weak shock absorbers, then you can ask the customer several leading questions:

- "How many miles since you replaced your shock absorbers?"
- "Have you noticed your car having a tendency to sway heavily on curves or to wander across the lanes?"
- "Does your car tend to bounce when you are driving on rough streets?"
- "Is your car hitting bottom on driveways and dips in the street?"
- "Does your car ride a little mushy and move up and down a bit?"

These are all indicators that the shock absorbers are weak or in need of replacement.

To sell shock absorbers, you must first discover the need. Second, you must tell the customer of the need. Third, you must explain how the customer will *benefit* from replacing the shock absorbers:

- Better, more comfortable ride
- Smoother, easier handling on the highway
- Easier control during braking, cornering, and on curves
- No bottoming or dragging of rear bumper from going into or out of driveways, bumps, or dips in the road
- Essential to the car's suspension system and steering control

Point out that while shock absorbers are seldom seen or noticed, they do have a direct bearing on ride, steering, handling, and braking. *Safety* and complete *control* at all times are your major selling points. Stress that the purpose of shock absorbers is to keep all four wheels in constant contact with the road. Many people think the main purpose is to give a soft ride. That is a secondary benefit. Safety and control are essential to good performance.

Show the customer what weak shock absorbers do. Many places have a demonstration device that lets the customer feel the difference. While the customer is feeling the worn shock as opposed to the new one, explain why a stiff shock is needed. Explain the double action that takes care of control needs at low, moderate speeds and at high speeds. Explain what is happening to the rear springs when the trunk or rear end is loaded with luggage or camping gear or is towing a trailer. Weak springs cannot be helped by new shock absorbers. Weak springs will have to be replaced. Show how overloading can cause tires to wear excessively and how weak shock absorbers cause uneven tire wear.

Ask for the order. A new set can be replaced easily within an hour, and often in less time than that.

Questions

1. What is the main function of a shock absorber?
2. How does the shock absorber work?
3. How is the shock absorber constructed?
4. What kinds of driving and loading require rear overload shock absorbers?
5. What are six advantages of rear overload shock absorbers?
6. Name three easy methods of inspecting to see if a car needs replacement shock absorbers.
7. How are shock absorbers best sold?
8. What are the benefits of replacing worn shock absorbers?

Project

From your training station's stock of shock absorbers, select one name brand that you want to sell. Give the selling points and superior features that you would point to in selling the best-quality model over the low-end or promotional model.

18

Selling and Servicing Spark Plugs

Objectives: After completing this assignment, you will be able to—

1. state the function of the spark plug;
2. describe the construction and design of the spark plug;
3. name the sizes of spark plugs;
4. explain the heat ranges of spark plugs and why they differ;
5. describe conditions that cause malfunctioning plugs; and
6. describe symptoms of spark plugs that show the need for service or replacement.

The Function of Spark Plugs

The modern automobile's gasoline engine is one of the most highly refined power sources that technology can develop. It has the ability to start easily, idle smoothly, and accelerate quickly. The modern gasoline engine is both durable and easy to maintain. The new advances in electronic ignition have given us an engine that can easily travel 20,000 miles without tune-up or adjustment.

The efficiency of the new engine is remarkable. Its ability to operate at all depends entirely on the spark plugs—tiny components that have no moving parts. The spark plug is a modern marvel of ceramic and metallurgic engineering. Metallurgic engineering is the science of blending metals together into special-purpose alloys.

The spark plug is exposed to more stress and corrosion than any other single part of the engine. A spark plug receives up to 40,000 volts of electricity at each rotation of the distributor. It is about 3 inches long, yet one end can be exposed to freezing outside air, while the other end inside the combustion chamber is exposed to 3,000°F. The spark plug must be so designed that it completely insulates the high voltage, provides instant heat, and then takes away that heat as rapidly as it produces it.

The spark plug must seal off the hammerlike blows of combustion pressures inside the combustion chamber. It must provide enough heat to ignite the gasoline-air mixture on every fourth stroke of the piston, then burn away the carbon deposits and carry away enough of the heat so that there is no preignition on the next combustion stroke. If the firing tip gets too hot, the engine will misfire. If it is not hot enough, carbon deposits build quickly, creating an insulating blanket that robs the high voltage of its spark.

The combustion chamber itself is highly corrosive. Each time the gasoline-air mixture ignites, there are carbon, acids, water, and intense heat. Since a spark plug has no moving parts, motorists may wonder why they wear out and need replacement. It is even more remarkable that a spark plug can last 20,000 miles under these conditions before being replaced.

Construction and Design

Shaped into a single unit, a spark plug has three basic parts. It has (1) a *ceramic* (made of earthen clays and glass) *insulator body* that contains a center electrode, (2) a *steel shell* with a

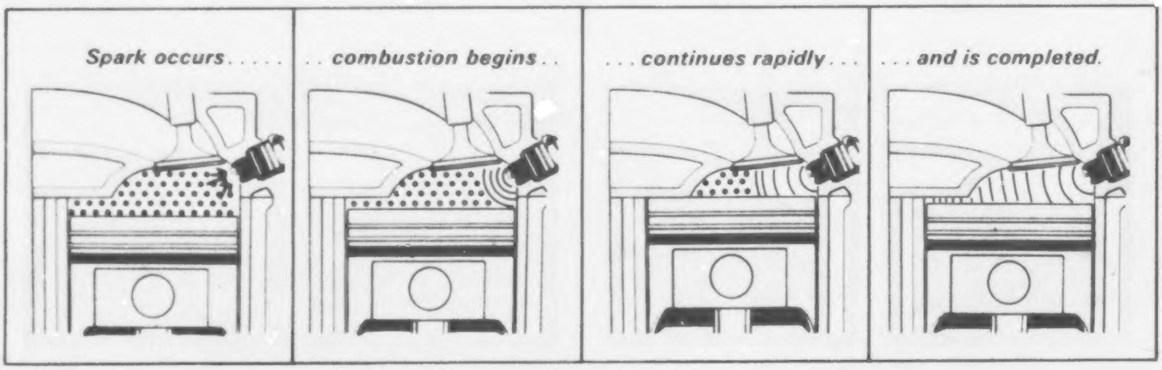

Spark occurs..... . . combustion begins . . . . . continues rapidly . . . . . . and is completed.

Fig. 18-1. How the spark plug works in the firing process

threaded end that screws tightly into the top of the combustion chamber and holds the ceramic body, and (3) a *firing tip* that has the center electrode and a grounded electrode that is attached to the side of the steel shell.

Each time the rotor inside the distributor cap makes a complete circle, it creates a circuit with each spark plug wire that delivers electrical current to each cylinder of the engine. This wire carries either 20,000 volts or 40,000 volts to the spark plug. Older engines that have a spark coil deliver about 20,000 volts. Newer engines with electronic ignition deliver 40,000 volts. The higher the voltage, the hotter the spark. The excessively high voltage must be delivered in a completely insulated atmosphere. Any minor crack, flaw, moisture, dirt, or carbon spot can drain off large amounts of the voltage.

The tip end of the spark plug has a special metal fitting that makes contact with the spark plug wire. The fittings are shielded by a rubber boot. The top fitting is attached to the center electrode. At the tip end, the electrode sticks out just enough to be exposed to the combustion chamber. At the bottom side of the spark plug shell, the grounded wire electrode extends over to the center electrode. There is an air gap between the two—they cannot touch or be too close or too far away. When the full charge of voltage comes through the center electrode, its energy is completely spent in the discharge between the gap of the grounded wire electrode. An intensely hot spark results, and this is what ignites and burns the gasoline-air mixture in the combustion chamber.

In older engines, the 20,000-volt charge did not burn the gasoline-air mixture completely. Some of it remained in the combustion chamber in the form of water, carbon, and acid. The older engines with spark coils and breaker points in the distributor will wear out a set of spark plugs in 10,000 to 12,000 miles. In addition, these engines produce polluting oxides and emissions that escape into the atmosphere. Emission control systems took care of part of the problems, but not enough.

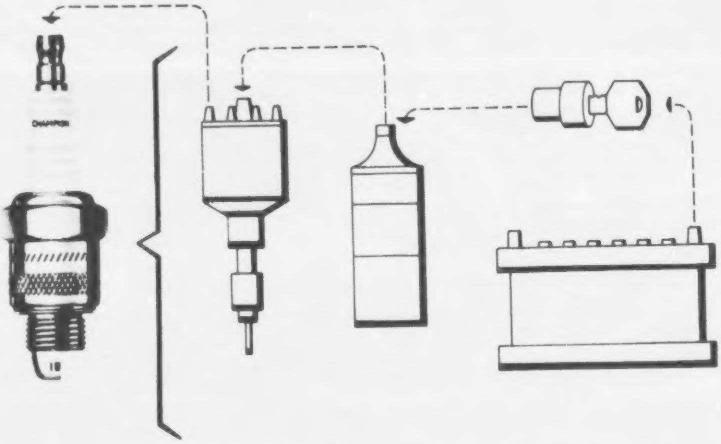


Fig. 18-2. Relation of the spark plug to the ignition system

In contrast, the modern engine (1975 on) is equipped with electronic ignition to deliver higher voltage. The increased voltage and a wider gap between the spark plug's electrodes mean a hotter spark to burn up nearly all of the gasoline-air mixture. This produces less carbon and fewer oxides, thus letting the spark plugs last longer while reducing polluting emissions.

Special-Purpose Plugs

The spark plug just described is the regular type. However, each automobile engine has special needs, so special-purpose plugs are designed for the modern automobile engine. The regular plug can be used in small engines, stationary power plants, outboard motors, and other marine applications. A complete stock of spark plugs to fit every type of engine and application will include many different types and sizes. You should know how to find the correct plug to fit the engine's requirements. Special-purpose plugs have slightly different internal design features.

A **series-gap** plug has an extra gap in the center electrode. The purpose of the gap is to increase the firing voltage. It is used where carbon fouling and electrode erosion are a problem. It is especially good for engines that are driven in town most of the time, have little opportunity for full warm-up, and need the extra firing voltage to burn away increased carbon deposits.

A **resistor-type** plug has a built-in resistor in the center electrode. It has a resistant capacity of about 10,000 ohms. Its purpose is to reduce the interference of the high voltage that disturbs radio and television signals. The regular plug has an inductive spark discharge that causes static in radio signals and wavy lines and picture roll in television sets when an automobile passes by.

An **extended-core** plug has a longer reach inside the combustion chamber than normal. It is also known as a *power-tip plug*. It has a hotter-than-normal spark, and its purpose is to produce higher heat in the combustion chamber at slow speeds. This type comes with or without a built-in resistor.

Spark Plug Sizes

The threaded end of the spark plug comes in two standard sizes for American-made automobiles. Most spark plugs are *14 millimeters* in diameter and require a special gasket to help seal off the high pressures of the combustion chamber. Slightly larger plugs are *18 millimeters* in diameter. These are tapered plugs that require no gasket. There are also 14-mm tapered plugs.

In addition to thread-end size or diameter, the spark plug ends have

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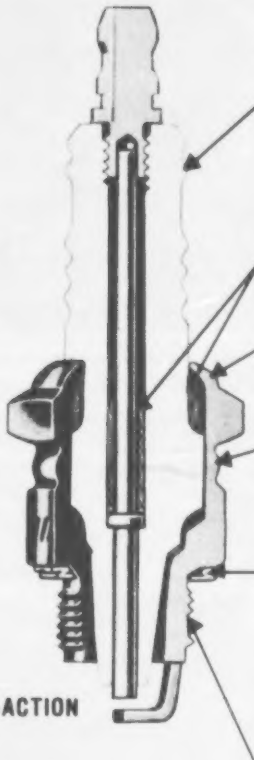
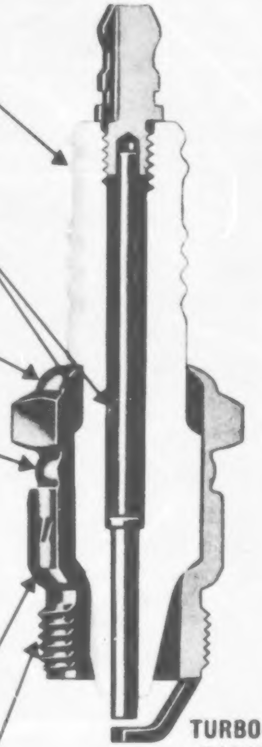
Illustrations in this assignment are provided courtesy of Champion Spark Plug Company.

Engineered Features



TURBO-ACTION



TURBO-ACTION TAPER SEAT

Insulator
Reduces "flashover" under humid conditions. High quality ceramic offers fast heat conductivity and resistance to thermal shock.

Sillment Seals
Assure freedom from troublesome leakage throughout life of the plug. Impervious to heat, oxidation or corrosion.

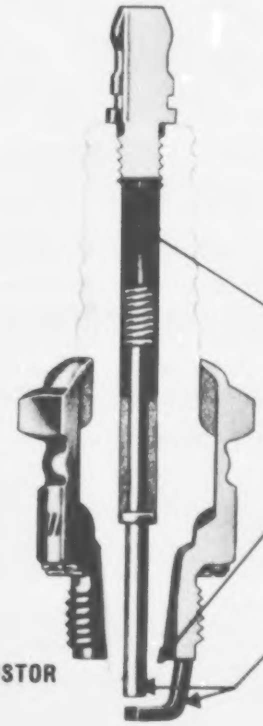
Silvery Plated Finish
Provides anti-rust protection, improves appearance of the spark plug.

Cold Press Construction
Strengthens the thermal bond between the shell and insulator. Improves heat transfer.

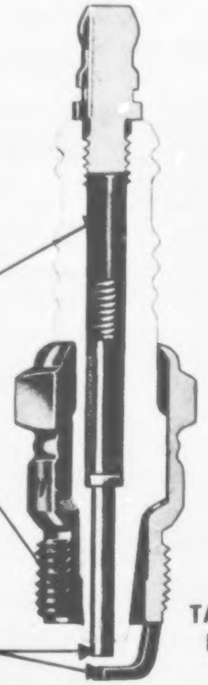
Attached Gasket
Simplifies installation and removal of plugs. Re-usable. Makes installation torque less critical when gasket is required.

Taper Seat Shell
Provides close tolerance installation in cylinder heads designed for this style of spark plug.

Precision Rolled Threads
Conform to the specifications established by the SAE and the International Standards Organization.



RESISTOR



TAPER SEAT RESISTOR

Resistor Element
Reduces radio and TV interference in recommended installations. Remains stable throughout life of spark plug.

Turbo-Action Firing End
Broadens heat range by operating hotter at low speed and cooler at high speed. Improves fuel economy where recommended.

Power Fire Electrodes
Resist corrosion and sparking attack. Maintain proper gap settings longer.

Fig. 18-3. Spark plugs are made for various purposes.

various lengths. Each engine has a combustion chamber design that requires a specific reach of the spark plug. If you install a plug that is too short in length, the firing tip will be isolated in a pocket. The gasoline-air mixture will not burn properly, and there will be a loss of power and too much unburned gas to foul the emission control system. If the plug is too long, it extends too close to the top of the piston. The tip will get too hot, causing preignition, intense detonation (explosion), and possible piston damage.

The reach of a spark plug is measured in lengths of 3/8 inch, 7/16 inch, 1/2 inch, and 3/4 inch. A few General Motors engines use the longer 3/4 inch size.

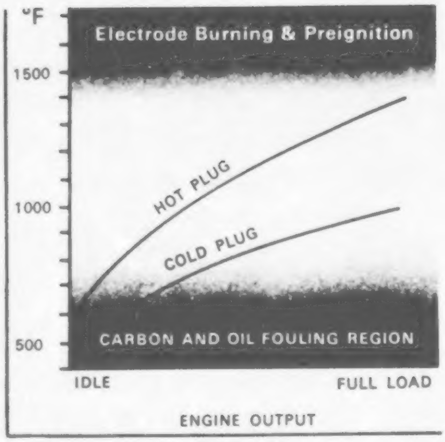


Fig. 18-4. Importance of plug heat ranges

Heat Ranges

A spark plug has to maintain an even flow of heat from the firing tip where the spark is produced. If the heat builds up, there will be a misfire because of preignition. ***Preignition*** happens because the combustion chamber is so hot that the gasoline-mixture ignites and burns on the compression stroke rather than the firing stroke. The entire timing cycle is thrown off, and you have too much power on one cycle and not enough on the other. The result is loss of power, sluggish idling, uneven running, and wasted fuel.

Heat is a critical factor for the spark plug. It must be hot enough to create a spark at the right moment. It must be hot enough to completely burn the gasoline-air mixture. It must be hot enough to burn away the resulting carbons from the combustion so that they don't build up on the spark plug tip. Yet, the spark plug must pull away enough of that heat to keep the combustion chamber from getting too hot. That is why the spark plug is such a marvel of engineering and why spark plugs have varying heat ranges built into them. Some engines are designed to run on "cold" plugs and some on "hot" plugs.

A cold plug will have a heat range that runs from less than 500°F to about 1,000°F. a hot plug operates from about 600°F to about 1,500°F (see fig. 18-4). The heat range of an individual type of plug will stay the same during its life. The major difference in heat range of plugs is in the design and length of the firing tip or center electrode. In figure 18-5, you can see how much variation there is in firing tip length from a cold plug to a hot plug.

A cold plug would be installed in an engine that operates mostly at highway speeds. A hot plug would be installed where the engine operates mostly at low speeds and long idling, and where engine temperature seldom reaches its maximum heat before being shut down. When an engine first starts up, it is said to be "cold." That is, the engine temperature is not at proper operating level. In-town driving, stop-and-go traffic, and long idling all produce cold engine operations. The engine is not efficient at low temperature operation. It does not have the power that it should, and it is wasting fuel. When the engine warms up to its normal temperature, it is fully efficient, at the peak of its power, and getting maximum fuel economy.

For today's driving needs, an engine needs a spark plug that has a variable heat range built into it. To do this, the plug must burn "hot" during slow speeds, during warm-up, and where idling puts no power load on the engine. The same plug must burn "cold" when the engine is running at high speed, is warmed up, and is operating under a load. To design a variable-heat plug, the firing tip is extended further into the firing chamber, but is shielded against the combustion heat by an extension of the insulator.

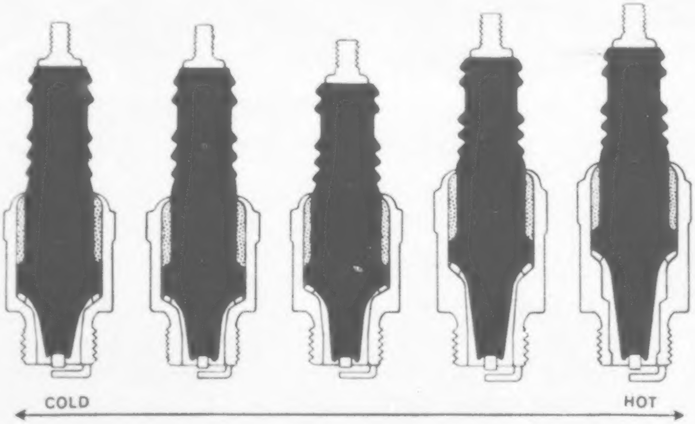


Figure 18-5

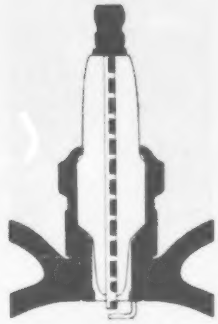


Fig. 18-6. **Wide electrode gap:** *The spark plug electrodes may be worn so badly that ignition voltage is insufficient to jump the gap. Misfire contributes greatly to increased hydrocarbon emissions. A plug in this condition should be replaced.*

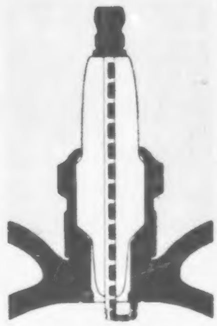


Fig. 18-7. **Bridged gap:** *Deposits may have bridged the gap so that the coil voltage is drained away without a spark occurring. Exhaust emissions are increased tremendously when this condition exists. This plug often can be cleaned and reinstalled.*

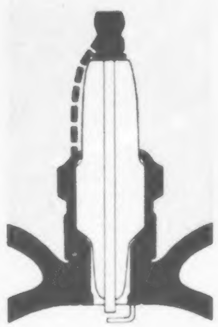


Fig. 18-8. **Flashover:** *Dirt or moisture . . . or a deteriorated "boot" . . . can cause voltage to short over the outside of the insulator (Champion's five-rib insulator guards against flashover).*

Ignition Problems for Spark Plugs

Assuming that the engine is properly tuned and that the fuel-air mixture is correct, there are three ways that normal ignition takes place. (1) When a spark plug is new, the spark occurs normally between the two electrode gaps. (2) After short use, a slight carbon deposit forms on the outer shell of the spark plug and grounded electrode wire. The spark occurs between the gaps, but with slightly reduced power because the carbon insulates the electrical voltage. (3) As carbon builds during engine operation, and as the inside temperature builds in the combustion chamber, the carbon holds back some of the heat and does not let it flow. The timing is thrown slightly off, and there is a tiny, almost unnoticeable amount of preignition from the heat. But it is not enough to be noticeable to the driver or to affect engine operation.

Those are normal conditions. However, after spark plugs have been in use for several thousand miles, and as conditions in the engine ignition system change, other problems cause spark plugs to begin losing their efficiency. Here are some of the more common conditions to look for.

1. Through normal use and firing, electrodes corrode and lose material. The *gap widens* between them (fig. 18-6), and the spark is not as hot as it should be. The fuel-air mixture does not completely burn, and there is a gradual loss of power and efficiency.

2. *Carbon-bridged gap* (fig. 18-7) means that carbon builds up and is not being burned away. It happens mostly from in-city driving and where the engine seldom warms up to full operating temperature. The more carbon on the firing tip, the less the spark. There is noticeable loss of power and increased fuel consumption.

3. *Flashover* (fig. 18-8) happens if the boot covering the connection between the spark plug and the spark plug wire is cracked, wet, or split. Excessive dirt and grease can hold moisture to create the same problem. Much of the voltage is drained away and does not get to the firing tip. The voltage flow is going outside the plug rather than through it. Insulator rings prevent flashover.

4. A *cracked insulator* housing (fig. 18-9) causes the same condition. The voltage flow is short-circuited from connector end to outer shell, then to the firing tip, with a tremendous loss of voltage. There is not enough to fire.

5. A *fouled tip* is covered with carbon (fig. 18-10). The voltage is flowing through the carbon and back into the cylinder head housing, rather than creating a spark.

Spark Plug Inspection and Servicing

Some of the above conditions can be corrected by cleaning and servicing.

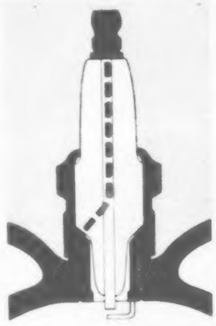


Fig. 18-9. **Cracked insulator:** *High voltage may short-circuit to ground through a crack in the insulator of the plug. Obviously, such a plug must be replaced.*

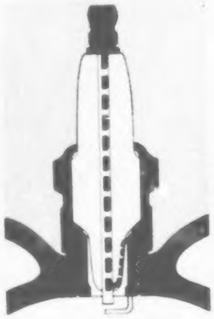


Fig. 18-10. **Fouled plugs:** *Conductive deposits may form on the insulator surface draining away ignition voltage. Another cause of air pollution. Plugs in this condition should be serviced and tested, or replaced.*

In most cases, unless the engine has mechanical problems, the spark plugs can be cleaned and regapped at least once before being replaced. In order to determine the condition of spark

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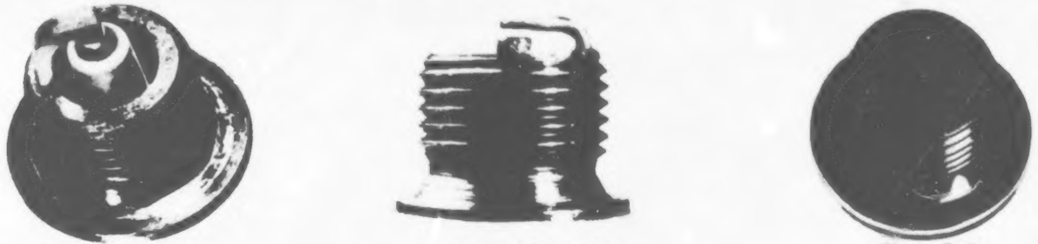
plugs, they must be removed from the engine and inspected visually.

The following conditions are common (see fig. 18-11). Some require servicing and cleaning. Others indicate replacement with new plugs. In some cases, the spark plug indicates other mechanical problems that need correction.

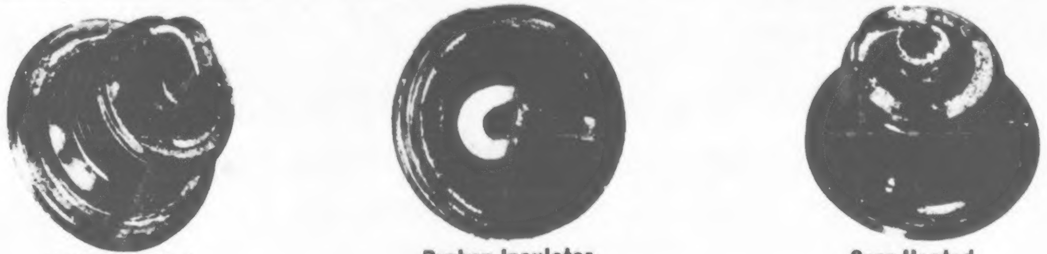
- Under normal conditions, the spark plug ends are fairly clean, and there is a light tan or gray carbon ash deposit on the insulator tip and electrode side wire. These plugs may be cleaned, checked for proper gap clearance, and reinstalled.

- If only one plug is fouled with oil while the others appear normal, it indicates a mechanical problem with one cylinder. It means possible ring damage, excessive ring wear, or a burned valve. A compression check should be made on that one cylinder.

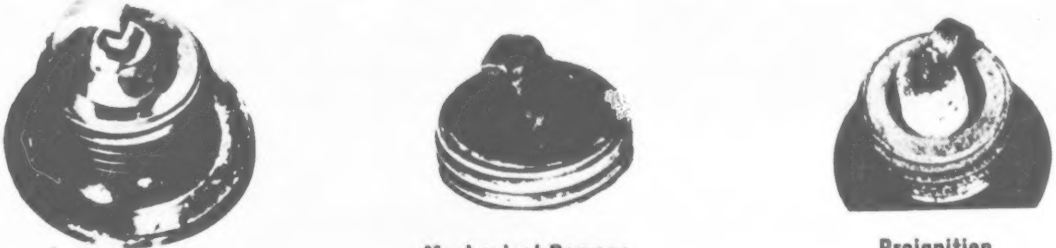
- If there is oil fouling on all plugs, it will appear as a heavy black deposit all the way around the electrode tip, insulator shield, and steel shell. This indicates a faulty carburetor or possibly excessive ring wear and oil burning. Check the mileage on the



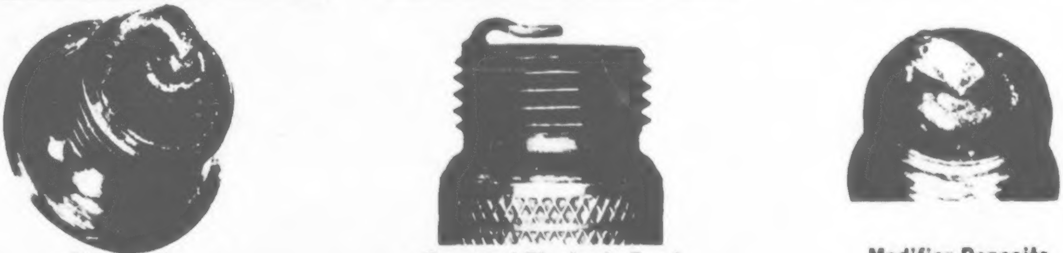
Normal Condition **Reversed Polarity** **Worn Out**



Carbon Fouled **Broken Insulator** **Over Heated**



Splash Fouled **Mechanical Damage** **Preignition**



Oil Fouled **Reversed Electrode Bend** **Modifier Deposits**

Fig. 18-11. Various plug conditions and the problems

odometer. If the engine has 60,000 or more miles, it's probably ring wear. If the mileage is not excessive, then it likely means a carburetor air-fuel adjustment is needed.

- If all plugs are worn but fairly clean, check the electrode clearance. Gaps of more than 0.008 to 0.010 inch mean the plugs should be replaced. Regapping will not last very long, and it is wasteful to try to reinstall worn-out plugs.
- Plugs with a whitish heavy deposit mean the plugs are running too hot. Check the spark plug number, and install a cooler-running plug.
- One or more plugs that appear to be badly burned with a partially melted or bent side electrode wire mean preignition damage. Check the intake manifold for possible warps. Check for cross-firing between crossed spark plug wires. Also, check to see if one spark plug has a longer reach than the others or is a different number.
- If all the plugs have a heavy caked deposit that is easily chipped off with the fingernail, it means impurities were in the gasoline. These plugs can be cleaned and reinstalled. Sometimes additives put in gasolines cause heavy caking. Gasoline transported in dirty tankers can cause the same condition. Rust on the steel shell means excessive water was in the gasoline.
- A chipped or broken insulator tip means replacement is needed. Also, look for fine-line cracks in the insulator shell or possible chips anywhere on the outer surface. A damaged plug will never fire correctly.
- A side electrode wire that is bent out of shape, has a loop, or is in the shape of a question mark should be replaced. Trying to rebend the wire will usually break it.

When cleaning plugs, use only the right tools and equipment. Use a wire brush to loosen heavy crusted deposits. Use air-blown abrasives for fine cleaning. Use an air gun to remove all abrasive particles after cleaning. Reset electrode gaps to original specifications for the engine, using a master specification chart or owner's manual. Replace gaskets before installing plugs in the cylinder block of the engine.

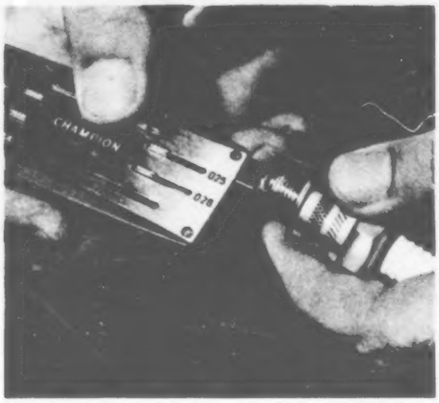


Fig. 18-12. Use a gap gauge to set proper clearances.

Installing New Spark Plugs

The use of the proper tools and equipment is essential when installing new spark plugs. The ceramic bodies of spark plugs are easily chipped and broken if not properly handled and installed. Dropping them on a hard surface may also produce a fine-line fracture that is hardly noticeable but will affect their performance. Use only a regular spark plug wrench with an extension handle. A torque wrench is needed to properly tighten the spark plugs.

First, set the clearances on the electrode gaps according to specifications (fig. 18-12).

Second, use the proper kind of spacing tool to measure clearances and to bend the electrode wire.

Third, put a compression washer or gasket on each spark plug before inserting in the engine block hole. Tapered plugs require no gaskets.

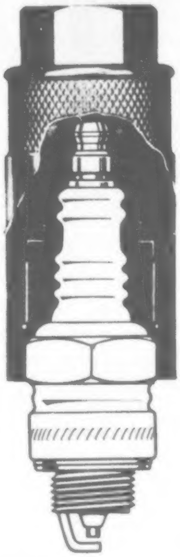


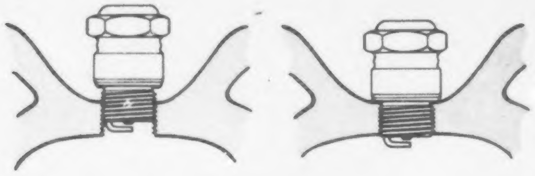
Fig. 18-13. Use the proper tools to install a spark plug.

Fourth, hand-install each plug, screwing them down as far as you can. This is important because it is easy to cross-thread a spark plug. If you begin tightening with a wrench, you will ruin the threading on both the plug and cylinder block.

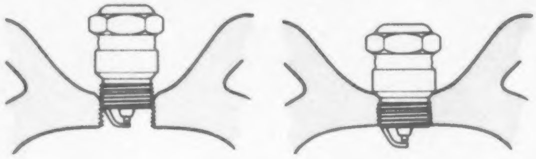
Fifth, tighten each plug with a torque wrench (fig. 18-13), setting the correct recommended foot-pounds. Use the following as a guide:

	Iron Head	*Aluminum Head*
14 mm gasketed	25-30 foot-pounds	18-22 foot-pounds
14 mm tapered	7-15 "	7-15 "
18 mm tapered	15-20 "	15-20 "

At least 90 percent of the heat flow away from the combustion chamber comes through the spark plug's steel shell. Good, tight seating of the plug is essential for proper heat flow dissipation (fig. 18-14). A torque wrench is the only assurance of proper seating and tightening. Too much torque may fracture the block. You must be particularly careful with engines that have aluminum cylinder blocks. Too little torque, and the plug may work loose, causing complete loss of compression on that cylinder. On gasketed plugs, the gasket itself does the actual sealing. Tapered plugs have a beveled seat that takes the place of the gasket.



Spark Plug with Gasket



Taper Seat Spark Plug

Fig. 18-14. Make sure plugs are properly seated and tightened.

Selling Spark Plugs

As with many other replacement parts, motorists seldom think of their engine's spark plugs. These are seldom seen, and many customers do not think they need replacement, particularly if the engine is running all right. If you have a regular customer and you keep service records, then you know about when the automobile needs replacement plugs. For others, you may not be able to spot the need for plugs until the customer tells you about problems and asks what is needed.

These are some common problems that indicate possible spark plug wear:

- Poor gasoline mileage
- No power, particularly when trying to pass or accelerate
- Rough idling and uneven running of engine
- Hard starting
- Engine dies often when idling
- Jerky performance at slow speeds

These symptoms are your cue to suggest checking and inspection to determine the spark plug's conditions. Check the mileage to find out how many miles the present spark plugs have. More than 10,000 miles on a spark-coil engine and more than 20,000 miles on an electronic-ignition engine usually indicate a need to replace the plugs.

Explain to the customer why plugs wear out and begin to fail. Tell how important it is to have clean, efficient spark plugs. Stress the fuel economy and safety factors of clean spark plugs. Explain how power is lost and that the cost of a new set of spark plugs can be offset in a short time in fuel savings alone.

Remove and inspect the plugs. Explain to the customer the condition of the plugs and what it means. If cleaning and regapping is all that is needed, then recommend that. Otherwise, suggest a fresh set of replacement plugs. Stress fuel economy, added power, better performance, and safety.

Ask for the order.

Questions

1. What is the function of the spark plug in a gasoline engine?
2. Why does a spark plug eventually wear out and lose its ability to provide a hot spark?
3. How is a spark plug constructed?
4. How much voltage is required to make a spark plug function properly?
5. How is the spark timed and generated in the combustion chamber?
6. What is the function of each of the three special-purpose spark plugs?
7. Name the sizes of spark plugs.
8. What is the heat range of a spark plug, and why does the range vary?
9. Name five conditions that cause a spark plug to misfire or become ineffective.
10. Name some common problems that indicate possible spark plug wear.

Project

If your training station services and replaces spark plugs, describe the recommended procedures for the following:

a. Routine inspection to determine cleaning, regapping, or replacement
b. Removal of spark plugs
c. Installation of spark plugs
d. Methods to determine correct size, gap, and type for the engine

Prepare this information as a brief report, and attach it to this assignment.

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Lighting and Electrical Accessories

Objectives: After completing this assignment, you will be able to—

1. name the six major circuits for automotive lighting;
2. explain the difference between Type 1 and Type 2 headlamps;
3. name the location and function of the main fuse block and circuit breaker;
4. state the principles to follow in testing for defective lamps; and
5. explain the procedures for a power test and a ground test.

Automobile lighting is essential to good visibility, identification, and safety. While lamps are not replaced often on a single vehicle, you should make a routine inspection to be sure all lamps are operating. Headlamps, rear lights, and license plate identification lights burn out most often. You should know how to test for replacement. You should know how the various circuits for lighting and accessories work, and how to test for troublesome circuits and connections.

The Lighting System

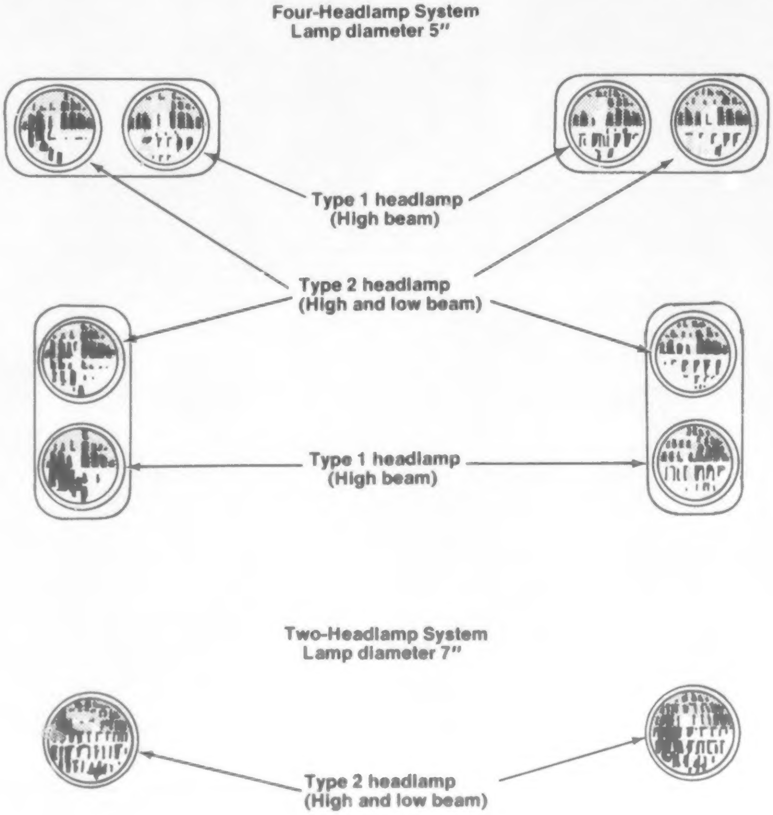
The average automobile or light truck has an extensive lighting system. It is complex, but not impossible to master if you know how each circuit is wired. There are usually six different circuits. All of them must take their power directly from the battery or from the charging circuit. Each light is controlled by a switch, and switches are located in various places inside the vehicle.

Headlamp Circuit

All automobiles and trucks have at least two headlamps, with some models having four. A vehicle may also have auxiliary lights up front, but these are wired on a separate circuit. The headlamps are turned on and off by a switch mounted on the instrument panel.

When there are only two headlamps, each is classed as a *Type 2* sealed-beam unit. Type 2 headlamps have both an upper and a lower beam and are identified by a number molded into the glass lens at the top, or by three connector prongs on the back. Four-headlamp systems have two Type 2 lamps and two Type 1 lamps. *Type 1* lamps are high beam only and are identified by the number "1" molded at the top of the lens, or by two connector prongs on the back.

On four-headlamp systems, if the lights are arranged horizontally, the outboard lamps will be Type 2 and the inboard lamps will be Type 1. If the



lamps are arranged vertically, the Type 2 will be on top and the Type 1 on the bottom.

The headlight beams are controlled by two switches. The main switch turns the headlamps on and off. A second switch—usually mounted on the floorboard—controls the high and low beams. A dash-mounted indicator light also alerts the driver that the high beams are on, and it is connected with the high/low beam switch.

Tail, License Plate, and Parking Lamp Circuit

While classed as a separate circuit, these lamps are turned on by the main headlamp switch. The main switch has two positions. The first position turns on the tail, license plate, side marker, and clearance lamps. On newer models, these lamps remain on when the second position switches on the main headlamps. The tail, license place, and parking lamps must remain on whenever the headlamp switch is on in either position.

Stop Lamp and Turn Signal Circuit

On most motor vehicles, the stop lamp and turn signal lamp are connected to each other and have the same wiring. The stop lamp switch is turned on when the brake pedal is depressed. Like the two previously mentioned circuits, the power comes directly from the battery. The accessories will operate only when the ignition is turned on, but all lights must be able to burn independently of the ignition switch. This is a safety factor that permits lighting even if the vehicle is stalled.

The stop lamp must be wired so that it comes on any time the brake pedal is operated, and the same is true of the turn signal flasher. It is a separate component that causes the current to turn on and off at a rapid pace, flashing the lights. The turn signal flasher is wired on the accessory side of the circuit and only operates when the ignition is on. On the other hand, the emergency or hazard warning lamp circuit uses the same lights, but operates independently of the ignition switch.

Since the brake lamp and turn signal lamp are one and the same, three separate circuits are required. (1) The brake lamp circuit must operate whenever the brake pedal is pushed. (2) The turn signal must operate either the right side or left side lamps, but is an accessory circuit that comes through the ignition switch. (3) The hazard warning circuit uses the same wiring, but must operate with the battery as the direct power source. The turn signal flasher operates either the right side or left side lamps when a lever on the steering column is pushed. A separate switch turns on the hazard warning and operates all lights except the headlamps. A sound or light device also indicates if the flasher is working properly. A slow flicker or a rapidly pulsing light means that one or more lamps are not working in the system.

Backup Lamp Circuit

Backup lamps are required on all 1971 model vehicles and later. It is a separate lamp and circuit that operates only when the transmission is shifted into reverse position. The backup lamp serves two purposes: (1) to give light at the rear to aid in night backing and (2) as a safety warning signal to persons in the rear that the vehicle is backing up.

Clearance and Side Marker Lamp Circuit

On all 1970 and later models, the front and rear sides of vehicles must have a side marker lamp. These are wired through the main headlamp switch and must turn on when the switch is pulled to the first position. If a vehicle is more than 80 inches wide, it must

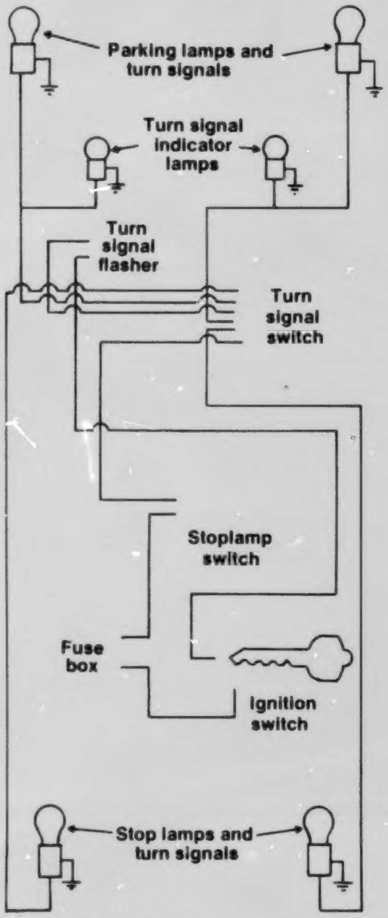

Parking lamps and turn signals
Turn signal indicator lamps
Turn signal flasher
Turn signal switch
Stoplamp switch
Fuse box
Ignition switch
Stop lamps and turn signals

Fig. 19-2. The secondary lighting circuits and their components

have clearance lamps to indicate the width and height at night. The front lamps are amber, and the back lights are red. These are also wired through the main headlamp switch and come on when the switch is opened at either position.

Accessory Lighting Circuits

In addition to the standard sets of lamps already mentioned, some vehicles are equipped with optional or accessory lighting. Each set carries its own circuit switch. Most accessory lighting is powered directly from the battery and does not come through the ignition switch.

Fog lamps are amber and are usually mounted lower than the main headlamps. They provide greater visibility in snow, sleet, rain, and fog. For safety, the tail lamps are wired into this circuit so they will be on whenever the fog lights are on, even if the headlamps are not.

Driving and cornering lamps are optional and are usually found only on luxury model vehicles. A driving lamp is a clear white light used to supplement the regular headlamp beams. It is operated by a switch other than the regular headlamp switch. Cornering lamps operate like side marker lamps, but have a clear light. They turn on with the turn signal switch. Additional light is thrown to the side to aid in better night vision when turning a corner.

Spot lamps are located only on the driver's side. It is a single sealed-beam unit that throws a focused beam. It is controlled only by a single switch and can be aimed by the driver turning the control arm. It draws its power directly from the battery and is independent of the ignition switch.

Replacing Lamps

Headlamps, tail lamps, parking lamps, and fuses are the electrical accessory items most often in need of replacement. Most headlamps burn out because they receive a crack or a hole from flying rocks. Sealed-beam filaments will not burn with oxygen, so the unit must be replaced. Check to make sure you are getting the right type of replacement—either Type 1 or Type 2. Look at the number molded into the upper lens, or check the connector prongs on the back. Type 1 has two connector prongs, and Type 2 has three. Rectangular-shaped lamps are classed as Type 1A or 2A, but they have the same beam arrangement.

If one headlamp is not working, check first for a crack or small hole. Remove the retaining ring and pull the lamp out to see if the connection is tight. An inoperative headlamp is nearly always defective and in need of replacement. If you find nothing in the wiring or connections and both headlamps will not burn, then you must trace the trouble through the wiring circuit back to the switch.

Other lamps that need replacing are much smaller and have a brass base. The base may have one or two contact points, depending on the number of filaments in the bulb. A bayonet base has two index pins or lugs jutting from the side. These guide and lock the bulb into position. Other bulb types use a screw-base, wedge, or cartridge type. The safest method of replacing bulbs and lamps is to look for the model or type number and replace it with exactly the same kind.

Fuses and Circuit Breakers

Every vehicle has at least one master fuse block, circuit breaker, or both. These are usually located under the instrument panel on the driver's side or on the firewall under the hood. Most American-made vehicles have a circuit breaker to protect the headlamp, tail, and brake light system. If a circuit breaker is found to be faulty, the entire unit must be replaced. Most all other lamps and fan motors and accessory items are protected by a fuse block. Fuses are small, round glass cylinders with a metal strip inside. A clouded glass or broken strip means a blown fuse. Remove and replace fuses with a fuse holder made especially for that purpose.

If a light or accessory item does not have a fuse on the fuse block, then check the wiring next to the unit. You will likely find a fuse in the wire itself housed inside a plastic case.

Testing and Locating Defective Lamps

Even though automotive wiring and circuits are rather complex, testing can be a simple process if you know what to do and where to test. Most testing can be done with a voltmeter, an ohmmeter, or a probe light. There are two basic principles to follow when locating an electrical circuit or faulty lamp.

1. If you are testing a multiple-unit circuit, begin the testing with the faulty unit. In other words, if only one lamp is not working, start the test at that unit and work back along each part of that circuit toward the switch and power source.
2. If an entire circuit is faulty, begin the test at the power source and work forward until the problem is found. Most likely, it will either be a loose connection or a blown fuse.

Power Test

To test for power in a 12-volt circuit, use a 12-volt test lamp. Use a 6-volt lamp for 6-volt circuits. Connect one lead to a ground—almost any metal piece—and the other to the circuit. If there is power in the wiring, the test lamp will light. If it does not, the circuit is dead. Work back through the circuit toward the battery or ignition switch. All switches must be closed or in the off position. To have power, the circuit must be complete.

Check each connection in the circuit to make sure each is tight. Use a test light or ohmmeter, and connect both leads to the circuit with the power removed. It will show if the circuit is complete between the two test points. A jumper wire can be used

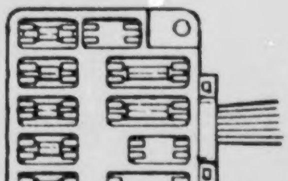


Fig. 19-3. Typical underdash fuse block

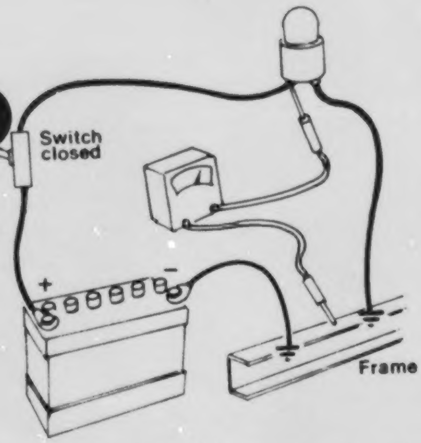


Fig. 19-4. Setup for power test of circuit

to bypass a switch. Make sure you do not use it to bypass a resistance-type circuit. A short circuit to ground will either damage the two components in the circuit or cause an electrical fire.

Ground Test

Many electrical circuit problems are a result of a faulty or poor ground. If a ground wire is mounted on plastic or fiberglass, it is ineffective. A ground wire should be run to a metal part. Resistance will build if there is corrosion or a loose connection. To test for ground, use a 6-volt or 12-volt test light. Touch one end to the ground wire and one end to the base of the lamp socket. The lamp will light if the circuit is *not* properly grounded. Remount the ground wire to metal, or check for a loose connection or corrosion.

Checking Headlamp Problems

Headlamps are the most crucial circuits to test. A potential danger exists when headlamps are not working properly. High and low beams in each lamp must be on or off as the switch is operated.

If *one headlamp does not light* on low beam, high beam, or both, then follow this procedure:

1. Check the lamp itself for a burned element, small hole, crack, or chip in the lens. Check the rear connector prongs for a tight fit.
2. Check the wiring harness. Frayed, split, cracked, or barren insulation may be the problem.
3. If those two are not the problem, then begin at the headlamp switch, using a 6-volt or 12-volt test light. Turn the switch on to check for power in the wiring. Touch one end of the probe to the connector ground terminal. If the probe lamp lights, replace the headlamp. If it does not light, then check the ground circuit for faulty or loose wiring, or a poor ground connection.

If *neither headlamp lights on low beam, high beam, or both,* use this procedure:

1. The problem is most likely the dimmer switch. Use the probe light at the dimmer switch terminals. If one beam or the other comes on, then the switch is defective and needs replacing.
2. If both terminals check okay for power, then there is an open circuit in the wiring between the dimmer switch and the headlamps. Check the wiring carefully for poor connection or a barren spot where a short circuit is likely.

If the *headlamps will not turn on,* follow this procedure:

1. The problem is most likely the fuse block or circuit breaker.
2. Start the check at the circuit breaker on the firewall. If you cannot find it, then check the fuse block underneath the instrument panel. Replace the burned fuse, or replace the circuit breaker.
3. If the lights still do not come on, then check the power to the main switch, looking for loose or corroded connectors.

If *headlamps dim excessively during engine idle,* the following are possible causes:

1. The battery is faulty and is putting out too little voltage or amperage.
2. Accessories such as radio, tape deck, fan, or other lighting are drawing excessive current and should be turned off. If headlamps still dim at engine idle and battery check is good, then the fault is in the wiring, switch, or loose, corroded connectors.

If *headlamps blink,* flicker, turn off and on, or otherwise act erratic, then follow this procedure:

1. The problem is likely a loose connection. Check the connector terminals at each headlamp for tight connections.
2. Check the terminals at the dimmer switch for tight connections.
3. Check the wiring to make sure it is not opening and closing a circuit with a bare spot in the insulation.

Other Trouble Spots

If the brake lights are not operating properly, the trouble may be in one of two places. The stop lamp switch may be faulty, or there may be a bad flasher unit. Sometimes the diaphragm spring gets weak, and the hydraulic type of stop lamp switch will hang in the "on" position. It can also be caused by too much pressure in the brake fluid line. A new switch should be installed.

A faulty flasher unit can create a number of problems. One or both of the turn signal lights may not operate. They may be too fast or too slow. The trouble may be a burned bulb or poor ground connection. The wrong type of flasher unit may have been installed. Check for burned bulbs, a blown fuse, or loose wiring.

Questions

1. Name the six major lighting circuits in an automobile.
2. What is the main difference between a Type 1 and a Type 2 headlamp, and how can you tell which is which?
3. How many different circuits are controlled by the main headlamp switch?
4. What is the purpose of the backup lamps?
5. Describe the location and function of the circuit breaker and main fuse block.
6. What two basic principles should be followed in testing for defective lamps?
7. Describe the power test.
8. Describe the ground test.

20

Mufflers and Exhaust System Parts

Objectives: After completing this assignment, you will be able to—

1. describe the functions of the exhaust system;
2. name the major parts of the exhaust system;
3. describe the purpose of inspecting the exhaust system, and name the specific things to look for; and
4. tell what things to check when looking for excessive noise in the exhaust system.

The Exhaust System

A vehicle's exhaust system does two major jobs: (1) it removes exhaust gases from the engine, and (2) it helps reduce engine noise.

Burned gasoline vapors and oxygen produce a deadly by-product—carbon monoxide. To make it fairly safe, carbon monoxide gas is piped to the rear of the vehicle where it passes harmlessly into the atmosphere. As long as the exhaust system itself is working properly, no harm will come to the driver or passengers. However, a faulty exhaust system with leaky connections or restricted passages can pass carbon monoxide into the passenger compartment. Dizziness and nausea are the first symptoms. Continued breathing of these gases can bring on drowsiness or unconsciousness. In fact, carbon monoxide trapped inside an airtight compartment is usually fatal to anyone inside. This is why a thorough inspection of the exhaust system is necessary.

All of today's automobiles have a clean air or emission control system. It is a part of the exhaust system and a regular inspection is needed to ensure clean air. Any restriction inside an exhaust pipe or muffler will create back pressure. This, in turn, forces misfiring, poor calibration of fuel-air mixture, and wasted fuel. There is also a power loss.

Parts of the Exhaust System

Every automobile engine has almost the same identical exhaust system parts. (1) The **exhaust manifold** bolts directly to the engine block and directs the exhaust gases from the cylinders into the (2) **exhaust pipes,** which direct the gases toward the (3) **catalytic converter** (on 1975 and later models of American-made cars) where the noxious gases are turned into harmless fumes. (4) The **muffler** reduces the roar to a soft, gentle purr. (5) The **resonator,** on some models, further reduces exhaust noise. (6) The **tail pipe** directs the final exhaust into the air behind the vehicle.

All of these components are replaceable. Each is supported by various types of brackets, hangers, and connector pieces. The difficulty in stocking all of these parts is that each make and model of automobile requires slightly different shapes, contours, and sizes of parts.

Inspecting the System

Your inspection of the exhaust system should include a visual and manual check of each component. A customer's complaint of excessive noise or roar is your first clue of a faulty system. The smell of exhaust gases inside the passenger compartment is another clue. Put the automobile on a lift, and get underneath. With the engine running, visually inspect and look for—

1. rust holes in the pipes and muffler;
2. loose joints between parts and broken, loose hangers and connectors;
3. a kink in the bends of exhaust pipes;
4. seams or welded joints that appear to have holes or be loose; and
5. excessive rust and corrosion on any part.

While looking for visual defects, listen for hissing or loud noises that indicate a hole or leak. Look at the exhaust manifold where it bolts onto the side of the engine block. Make sure the gasket that seals the joint shows no signs of leakage.

Push up on the muffler and resonator to make sure it is tight at both connecting ends of the pipes. Slap them sharply with the palm of your hand, and listen for broken or rusted baffle plates inside.

The pipes that conduct the gases toward the rear are formed into all kinds of twists and contours. Each must fit the underside of a particular make and model. These twists and bends must be smooth and have no kinks or sharp bends in them. If kinks are present, the pipe will not have a smooth flow, and gases will be restricted. Replace any pipe section that has a kink or obvious sharp bend.

Generally, the kink cannot be removed without breaking the metal.

Heat Riser Valve

On the side of the exhaust manifold is a control known as the heat riser valve. It works on the thermostatic principle so that it is automatic. The valve preheats air before it is taken into the carburetor. When the engine is cold, the fuel-air mixture is directed downward around the manifold. As the engine runs and get to maximum operating temperature, the valve shuts off and the air is no longer preheated.

The valve itself actually controls the flow of hot exhaust gases toward the intake manifold where it preheats the fuel-air mixture. The valves are either operated manually by a thermostatic spring or vacuum-operated (most 1975 and later models). On the spring type, check to make sure the spring is not restricted. A stuck valve causes all types of engine operating problems, including rough idling and fuel wasting.

Muffler Replacement

Muffler replacement is fairly easy if you have the right tools and equipment. Raise the automobile on a hydraulic car hoist, and secure the safety locks. If floor jacks or standards are used, check them to make sure they are stable and will support the weight of the car.

Removal

Apply penetrating oil liberally. Squirt it into the joints where the muffler fits into the pipes. Squirt it on the nuts and bolts that secure the pipes to the hangers. Allow the penetrating oil to soak in for a few minutes. It dissolves rust and corrosion and helps in disconnecting the joints.

First, remove the rear muffler clamp with a rachet-type socket wrench or an air-impact wrench. If the nuts are badly rusted, apply more penetrating oil and let it soak for a few more minutes. Badly corroded nuts may have to be sawn off with a hacksaw, and a new clamp installed. Work the tail pipe section up and down, pulling back until the joints come free of each other.

If the tail pipe is so corroded that the joints won't separate, then use a chisel to cut slits in the muffler connecting section. Use an air-impact wrench with a chisel attachment to cut the connection completely and free the

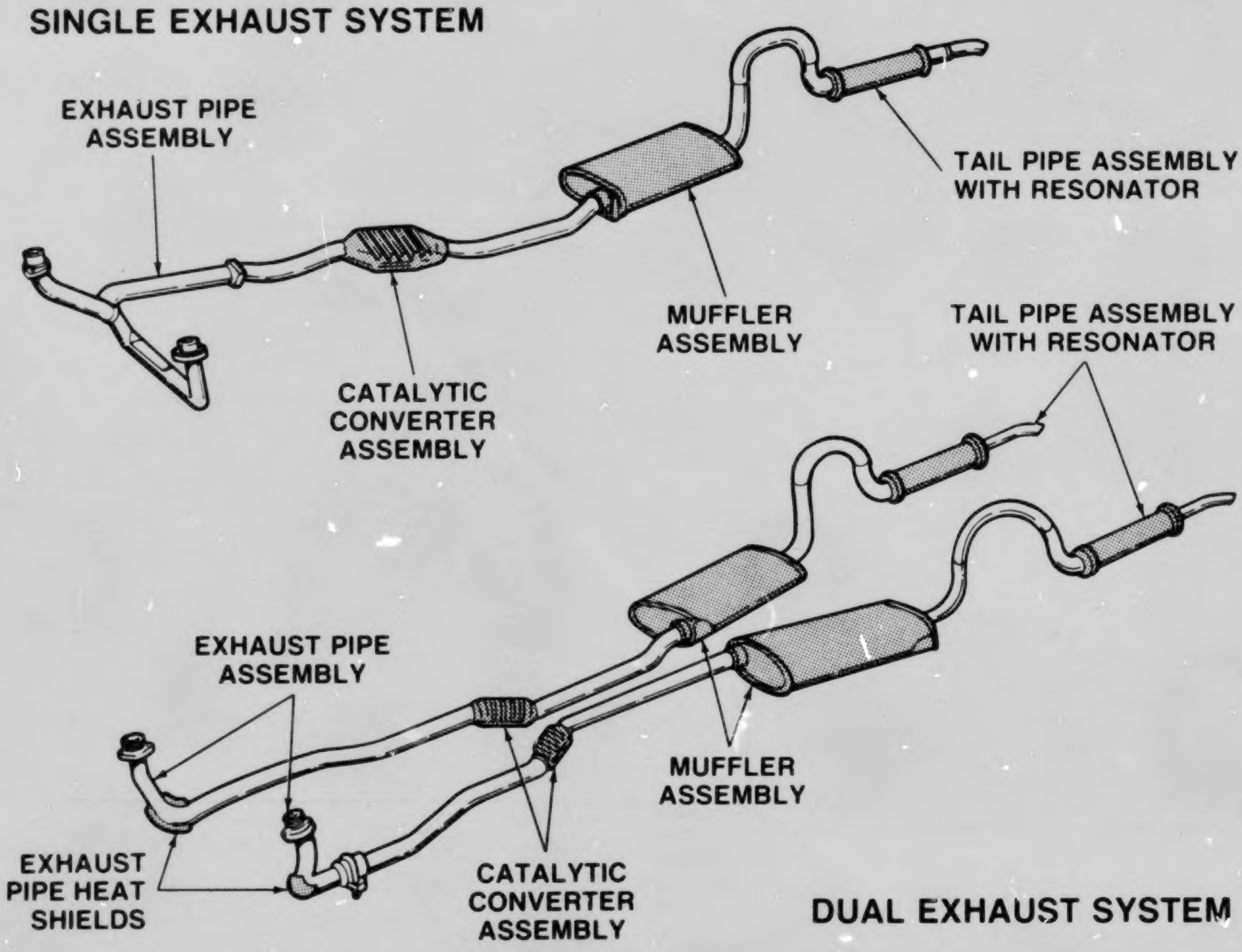

SINGLE EXHAUST SYSTEM
EXHAUST PIPE ASSEMBLY
TAIL PIPE ASSEMBLY WITH RESONATOR
MUFFLER ASSEMBLY
CATALYTIC CONVERTER ASSEMBLY
TAIL PIPE ASSEMBLY WITH RESONATOR
EXHAUST PIPE ASSEMBLY
MUFFLER ASSEMBLY
EXHAUST PIPE HEAT SHIELDS
CATALYTIC CONVERTER ASSEMBLY
DUAL EXHAUST SYSTEM

Fig. 20-1. Parts of the exhaust system. (Courtesy Chrysler Corp.)

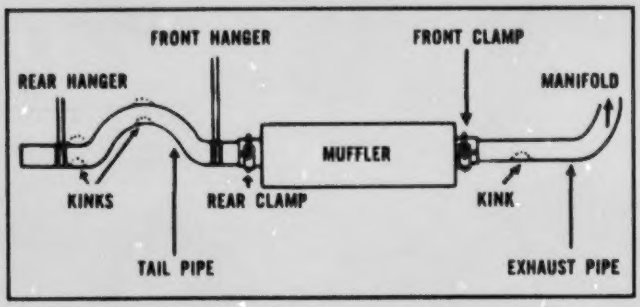

FRONT HANGER
FRONT CLAMP
REAR HANGER
MANIFOLD
MUFFLER
KINKS
REAR CLAMP
KINK
TAIL PIPE
EXHAUST PIPE

Fig. 20-2. Look for kinks, holes, rust, and loose clamps and hinges when inspecting.

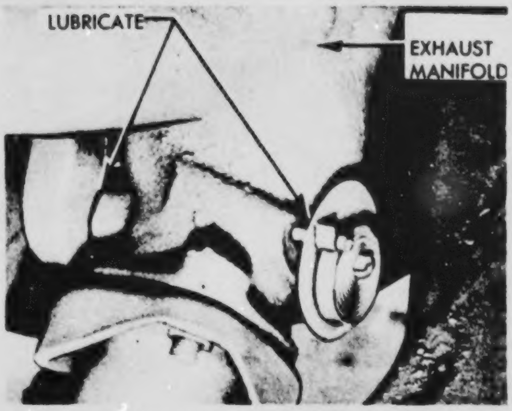

LUBRICATE
EXHAUST MANIFOLD

Fig. 20-3. Exhaust manifold valve should move freely. Use special solvent to loosen carbon binder. Do not use motor oil.

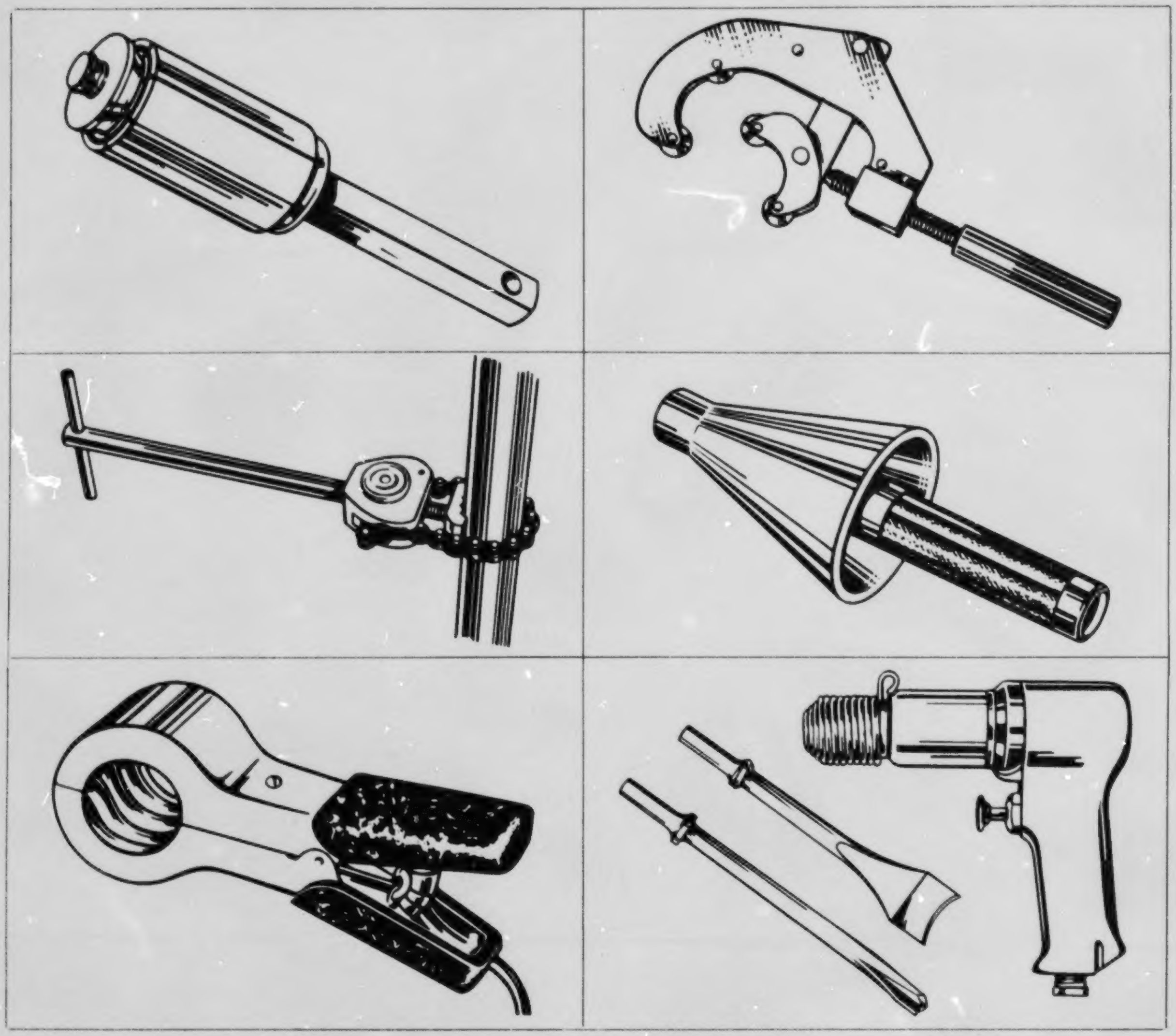


Fig. 20-4. Tools for muffler removal and installation

muffler. If the tail pipe section fits over the muffler housing, then use a pipe wrench to twist the muffler free.

Second, remove the front muffler or exhaust pipe section the same way as the rear. Use penetrating oil on all joints and rusted nuts and bolts of the hangers.

Third, if the muffler has welded joints, the weld must be cut with a pipecutter tool. Removal is done after the joints are cut through. After removing the muffler, dress the exposed tail pipe and front pipe connections. Burrs and rough edges should be dressed down with a file and emery cloth. The opening must be round. If it is out of shape, the muffler will not fit, and gases will leak.

Installation

If the openings of the tail pipe and front pipe are slightly out-of-round, use a flaring tool to make them round. Select the proper muffler for replacement. Check it with the one just removed to make sure it is the same size.

First, in nearly all cases, you will need to replace the C-clamps that support the pipes. Slip the clamps over each pipe end, about 2 inches from the edge. Look at the muffler ends to see the direction. They will be marked with an "inlet" and "outlet" side. The inlet side goes toward the engine.

Second, install the muffler into the tail pipe section first. The slits in the connecting ends should be completely covered so there is no crack for gas leakage. Push the muffler into place, making sure it is securely connected to the exhaust pipes. Make sure the top of the muffler is clear of the floor of the vehicle.

Third, slide the C-clamps over the slits of the muffler ends, and tighten the bolts. Check again to see that the pipes and mufflers are securely fastened on the hangers. Adjust the pipes to make sure they do not touch the frame, body, axle, springs, or floor. A final check is essential to make certain the tail pipe section is not touching or resting on the fuel tank.

Fourth, start the engine, and make a final visual and audio check for leakage or loose joints. Before the engine has a chance to warm up, run your hand over the joining piece at the muffler to make sure no gases are leaking from a loose joint.

Tail Pipe Replacement

Most tail pipe sections are easily removed and replaced. It is best to hoist the car on a lift that allows the rear wheels to drop to their full length. You need the full clearance between the rear axle and the tail pipe. If that type of lift is not available, then you should jack the rear end until the wheels drop to their full extended length. On some models, it may be necessary to unshackle the shock absorber in order to gain enough clearance.

Liberally squirt penetrating oil on the bolts that hold the rear tail pipe section to the hanger. Allow it to stand for a few minutes to loosen and dissolve the rust. Use a socket wrench or air-impact wrench to remove the clamp by loosening the bolts. Twist

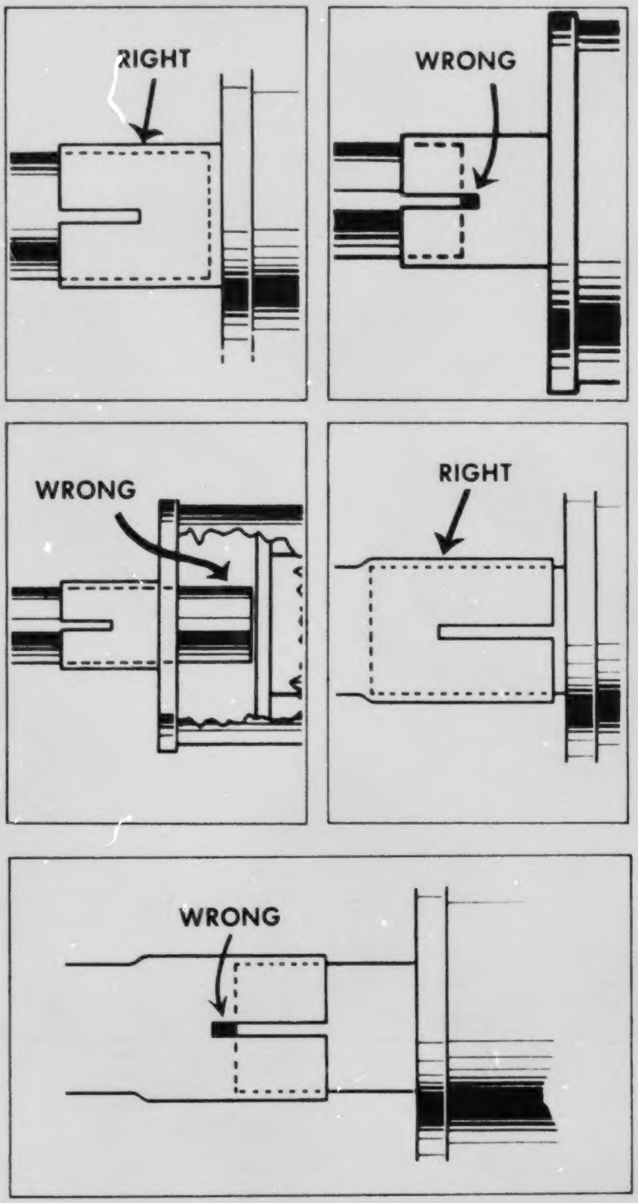


Fig. 20-5. Correct methods of installation

the tail pipe until it comes free from the muffler, and slide it outward toward the rear end.

On badly corroded pipes and mufflers where the tail pipe section itself fits inside the muffler, you may need to use another procedure. Use a hacksaw to cut the pipe at an angle just beyond the muffler. After you remove the pipe, use pliers to twist the remaining section free from the muffler opening. File the opening smooth, and use emery cloth to remove burrs and rust scale.

Replace the tail pipe with a new section, working it into position from the rear toward the muffler. Make sure the connection between the pipe and muffler is firm and makes a good, tight fit. Remount the hanger hardware. Make a final check for alignment and firm mounting. There should not be any play or rattle. Make sure the tail pipe section is not touching or resting on the fuel tank.

Checking for Noise

Many exhaust systems will be unusually noisy or have rattles. In most cases, this is caused by parts being too loose or out of alignment.

First check to make sure the joints between connecting parts are tight and firm. Second, check to make sure that there is proper clearance between all parts and the other parts of the car. Nothing should be touching the frame or underside of the automobile. Third, check for restrictions. When an exhaust system gets hot, the metal expands. Sometimes, the expansion may be as much as 3/4 inch. If the parts have been pushed together where no expansion can take place, then the pieces may bow out of line and touch the underframe.

Catalytic Converters

All American-made automobiles from 1975 models and later are equipped with a catalytic converter. These are usually mounted in the exhaust system just ahead of the muffler. The converter itself looks like a muffler. The purpose of the converter is to eliminate noxious, poisonous gases by converting them to harmless gases. It is part of the total emission control system.

Early models of some converters will need the pellets inside replaced. This should be done only by an authorized dealer, using the specifications and parts recommended only for that automobile. At this time, changing or replacing catalytic converters should not be attempted by an unauthorized agency or person. Neither should you attempt to remove the exhaust pipe from the converter itself. If it is rusted through, then recommend that the replacement be done by an authorized dealer.

Questions

1. Why is it wise to give an exhaust system a thorough inspection?
2. In addition to exhausting gases, what other functions are performed by the exhaust system?
3. What are the six major parts of an exhaust system?
4. When inspecting an exhaust system, what are you looking for?
5. What things do you check when looking for excessive noise in the exhaust system?

Objectives: After completing this assignment, you will be able to—

1. **explain why radiator and heater hoses wear out and need replacing;**
2. **describe signs that indicate a failing radiator or heater hose;**
3. **tell how drive belts are critical to the engine's operation;**
4. **tell why drive belts wear out and need replacing; and**
5. **explain how a badly fitted belt affects engine performance.**

21

Hoses and Drive Belts

All hoses and drive belts require periodic inspection and occasional replacement. They are part of the normal stock carried by most petroleum marketers and retail auto service places.

Hoses

Replacement hoses under the hood are of three main types. Two *radiator hoses* connect the water supply from the engine block to the radiator. *Heater hoses* circulate hot water from the block to the heater core inside the vehicle. *Hydraulic hoses* are used for power steering and power brakes, and a variation of this type is used in air-conditioning systems.

Radiator and heater hoses most often need replacement. In today's modern automobile engines, water temperatures and pressures have been greatly increased for more efficient operation. For this reason, the radiator hose is subjected to temperature extremes, high sustained heat loads, and great water pressures. The radiator hose is a vital flexible link between the engine and the radiator. One hose conducts the hot water from the top of the engine into the top of the radiator where it circulates downward to the bottom. Another hose distributes the cooled water back into the engine where it will pick up more heat. The water is being constantly circulated while the engine is in operation. "Water" is actually an incorrect term. All of today's engines use a "coolant," which is most often a water-antifreeze mixture that is used for year-round operating conditions. Some coolants have no water at all, but are strictly a chemical compound.

Structurally, radiator hoses are a rubber compound reinforced with tire cord material. While rubber is the best material known for this purpose, it still has a limited life. Radiator hoses have four enemies that shorten their life—heat, pressure, ozone, and oil.

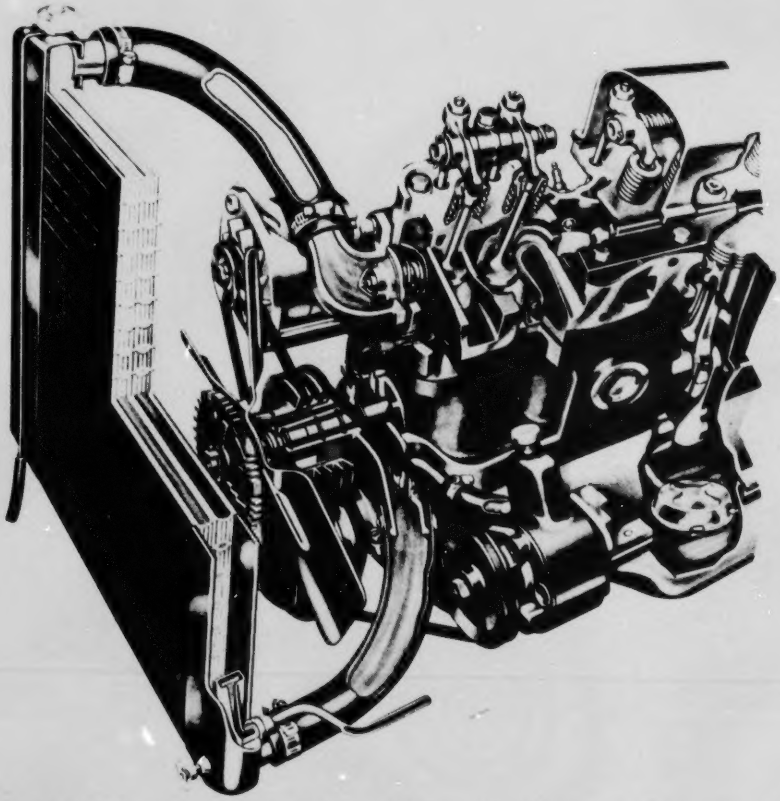


Fig. 21-1. The hoses and belts that help operate the car's cooling system. (Courtesy Gates Rubber Co.)

The combination of all these makes the hose deteriorate. The deterioration often begins inside and works outward. So, a hose can be in poor condition, yet outwardly appear to be in good shape. Looks alone are not a good test. The coolant inside and the oil on the outside combine to make rubber swell, soften, and finally burst. Age and heat will cause the rubber to lose its flexibility, and it will begin to harden and split.

Inspection

Each time you check a vehicle under the hood for routine servicing, you should certainly inspect the radiator, heater, and hydraulic hoses. The top radiator hose should be gripped and squeezed hard. There should be no visible signs of a hairline crack or split. If the hose appears to be swollen or slightly bulging at the connecting clamp, it is likely to fail within a short time. Look for signs of leakage. Screw-type clamps can be tightened with a screwdriver, but a spring-type clamp should be replaced rather than attempting to tighten it.

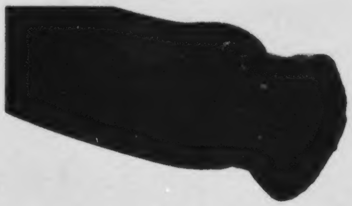
Heater hoses are smaller in diameter and much thicker, so a squeeze test will not work on them. You must observe the hose carefully, looking for cracks, splits, age checking, and signs of leakage, particularly at the connecting clamps. A leak in a heater hose is just as critical as one in a radiator hose. Even if the heater is not on, the hot water circulates continuously in the system. One small break in any of the hot water hoses will soon empty the coolant, and that is a serious mechanical failure of the engine. Your spotting and suggesting a replacement hose is a favor to the customer. Never hesitate to show a bad hose or leaky connecting clamp and to suggest a replacement.

Replacing Radiator and Heater Hoses

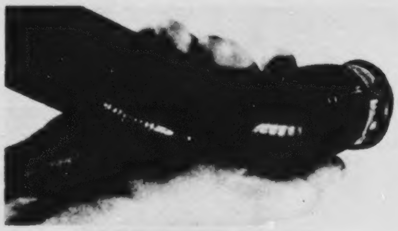
The replacement procedure for radiator and heater hoses is fairly simple on most makes and models. On some models, access to the connecting clamps means the removal of other equipment. Generally, the following procedure is recommended for most makes and models of automobiles and light trucks.

1. Place a cover over the fender well on the side on which you are working. Assemble the necessary tools. For an upper radiator hose replacement, partially drain the radiator coolant into a clean container. For a lower radiator hose, you must drain the entire radiator contents into a container.

2. Remove the old clamps from both ends of the radiator hose or heater hose. For a radiator hose, make sure you find the right replacement for the make, model, and engine size. Many radiator hoses are preshaped. Some are designed to be flexible and can be bent to the desired shape.

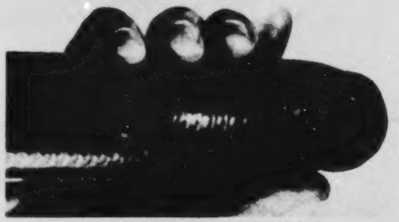


OIL SOFTENED HOSE



HARDENED HOSE

FLAKING HOSE



CRACKING HOSE

Fig. 21-2. What to look for when inspecting hoses (Courtesy Gates Rubber Co.)

3. Examine the openings where the hose slips on. Clean off any residue, scale, or rust. Wipe clean and make sure there is no oil or grease on the openings. Slip on the new hose with the clamps already on the hose and in place. Adjust the clamps so they are in the closest position to the end of the hose. The clamp must be completely over the jutting pipe opening. Tighten the clamps securely.

4. If spring-type clamps were originally used, it is usually better to replace them with a screw type. The old clamp can be reinstalled provided the hose connection was not leaking and the spring clamp has not been bent or is excessively rusty.

5. For heater hoses, remove the old hose, and use it to measure the exact length of the new hose. Heater hose comes in rolls, and you simply remove as much as you need. A sharp knife will cut the hose. Make sure you cut cleanly at a 90° angle and not diagonally. Reinstall the connecting clamps, and then put the new hose in place. Adjust the clamps, and tighten securely.

6. After hoses have been installed, start the engine, and let it run until the water begins to circulate into the top of the radiator tank. While the water circulates, add the coolant that was drained, pouring it back into the radiator. If it does not fill the tank to the proper level, add more coolant until it does. Shut off the engine, and check the connections for possible leakage.

Replacing Hydraulic Hoses

Hoses that connect the power steering and brake pump to their connecting parts, and hoses used in the air-conditioning system, are special types. They have fitted ends and must be exactly correct if being replaced. Signs of faulty or damaged hoses are obvious oily accumulations on the hose or at the connecting ends. These must be replaced only with special hoses made exactly for the purpose and make and model of the unit. Use only the proper tools. You should know the procedure for replacing either type of hose before undertaking the job. Consult a service manual for the exact step-by-step procedure and replacement parts. Inspect the fluid levels after each job, and replace lost fluids with the proper refill.

Drive Belts

The water pump, generator or alternator, air-conditioning compressor, and power steering/brake pump are driven by belts. The lower pulley on the engine block is the power source for all these. It is connected directly to the crankshaft.

Drive belts are rugged and dependable, but they need occasional replacement. Like the hoses, if one fails, it usually means a complete engine shutdown until it can be replaced. So you are performing a vital service to inspect and suggest replacement of any damaged belt you see. You should look at and test all belts during every routine under-the-hood inspection.

Drive belts fray and wear out from excessive heat, friction, and oil and grease that gets on them. All rubber products lose their flexibility and strength from these three enemies. They get their strength from the tire cord structure inside each belt. When the rubber surface begins to wear, the cords fray and begin to show through. Surface cracking, splits, and other signs of wear can be easily noticed.

Not only must the belts stay together to drive the various components, they must also be properly tensioned. Too loose a belt will not turn the pulley at the right speed. It will make excessive noise, cause the engine to overheat, or reduce the voltage produced by the alternator. Too tight a belt will warp the pulleys, pull them out of line, and cause premature failure of the belt.

The best way to inspect belts is to remove them completely from the engine. This is not practical most of the time. Look at each belt carefully, particularly the inside surface next to the pulley. Use a flashlight so that you can see and go all the way around each belt. Ground the ignition coil lead, and crank the engine several times so that each belt travels part way around. Grounding the coil will prevent the engine from starting.

A belt with a glazed surface on the sides and bottom will not grip the pulley as it should. A belt has to fit the pulley snugly—not too wide, too narrow, or too high. The belt pulls by friction on the pulley sides, so the fit must be snug and exact. If the bottom side of the belt is shiny, it means the belt is too tightly tensioned and should be loosened. A belt should be tensioned properly with a tension gauge.

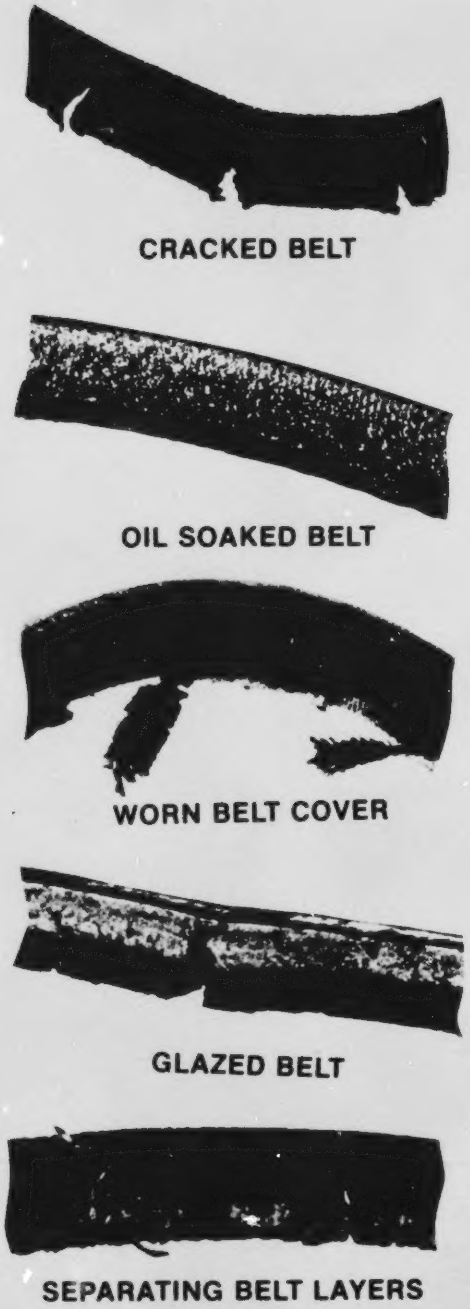


Fig. 21-3. What to look for when inspecting drive belts. (Courtesy Gates Rubber Co.)

If you do not have one, you can use a manual adjustment that is fairly accurate. Press your thumb against the belt. There should be a slight amount of give, but not more than ½ inch.

Inspect the pulleys for signs of misalignment, warp, bends, kinks, or rough spots that may cause the belt to wear unevenly or too fast. Crank the engine several times to see if the pulleys are properly aligned and not running with a wobble or uneven revolution.

Check your specification book accurately, and make sure you are getting the right stock number belt for the make, model, and size engine. Never try to force a belt onto two pulleys by using a pry bar and cranking the engine. Loosen the pulley arm, and move the centers of the pulleys toward each other. Slip on the belt, and readjust the arm until the belt is the proper tension. Then tighten the bolt.

After the belt has been installed, start the engine and let it idle for a few minutes. Observe the belt and pulleys to make sure there is no slipping, squealing, or uneven running of the two. A belt may be all right, but making excessive noise. For example, a squeal may be heard when the engine is accelerated. That is belt slippage and indicates that the pulleys should be pulled further apart. A squeaking noise is usually heard during engine idle. This indicates too much tension on the belt and that it needs a slight loosening. Squeaks may also indicate pulleys out of alignment.

A thump or slapping noise indicates a loose belt that must be tightened considerably. Also check the pulley grooves to see if they are dirty or have some foreign object causing a thumping noise. It is not recommended that you use any kind of belt dressing or preparation to cure a squeal, squeak, or other belt noise. You may temporarily take care of the noise, but not solve the problem. Any preparation that contains petroleum solvents and waxes will eventually harm the rubber compounds of the belt.

Store new belts in a cool, dry place away from heat or direct sunlight. Both will cause the belts to take a set during storage, and they will never fit properly. Store new belts away from lubricants, fuels, and other petroleum products.

It is a good idea for motorists to carry at least one or two extra drive belts with them. In case of belt breakage or failure on the road, a new belt can save a long, troublesome delay. When you sell a belt as a replacement on the car, suggest the customer keep a spare in the trunk, the same as a spare tire.

Questions

1. Why do radiator hoses wear out and need replacement?
2. What are some sure signs of a failing radiator or heater hose?
3. What precautions should you observe in replacing hydraulic and air-conditioning system hoses?
4. How are drive belts critical to the engine's operation?
5. Why do drive belts wear out and need replacing?
6. How does a badly fitted belt affect engine performance?
7. Describe the manual procedure for tensioning a belt.

Projects

1. Give a step-by-step procedure used by your training station for replacing a radiator or heater hose. What tools are required for this job? How do you check the accuracy of your work once the new hose is in place? Write this in the form of a brief report, and attach to this assignment.
2. Give a step-by-step procedure for changing out a drive belt. You may select any drive belt and any make or model of automobile as an example. What tools are necessary for this job? How do you check the accuracy of your work once the job is completed? Write this in the form of a brief report, and attach to this assignment.

Objectives: After completing this assignment, you will be able to—
1. name the major parts of the wiper and washer systems;
2. tell why wiper blades need constant replacement;
3. name conditions that indicate blade replacement; and
4. describe the service procedures for a washer system.

22

Replacement Wiper and Washer Parts

Though small and usually unnoticed, windshield wipers and washers are a great safety factor. The wiper blades themselves wear out quickly and must be replaced often. All other parts of the wiper/washer system seldom give problems.

The System and Its Parts

All of the later model cars have electrically operated windshield wiper motors. Earlier models may still have a vacuum-operated system. The motors are sealed units and seldom give problems. If they fail to function, it is usually because of corroded terminals, faulty wiring, or a blown fuse. Check these first if the motor fails to operate.

Another smaller motor operates the washer system. It may be located in the reservoir itself, or as a separate unit mounted beside the reservoir. It is a sealed unit that forms a pump to direct a spray of water onto the windshield. Tubing and spray nozzles complete the remainder of the washer system.

The windshield wipers are in two parts—the wiper arms and the rubber-tipped blades that actually clean the windshield. It is the wiper blade that needs attention and frequent replacement. In constant use, the blades will probably not last more than three to six months. The constant back-and-forth motion, the amount of tension, and the extremes of temperature changes cause the rubber to soon wear out and become hard and brittle. A blade that is used very little will soon deteriorate because the sun, wind, and heat will sap the flexibility from the thin rubber squeegee.

Other conditions indicate blade replacement. A bent refill blade will not make complete contact with the glass surface, leaving dulled, dirty streaks. Sometimes the squeegee will split, and the blade does not give a clean sweep across the glass. The rubber may become too soft and have a greasy feel. It will not clean effec-

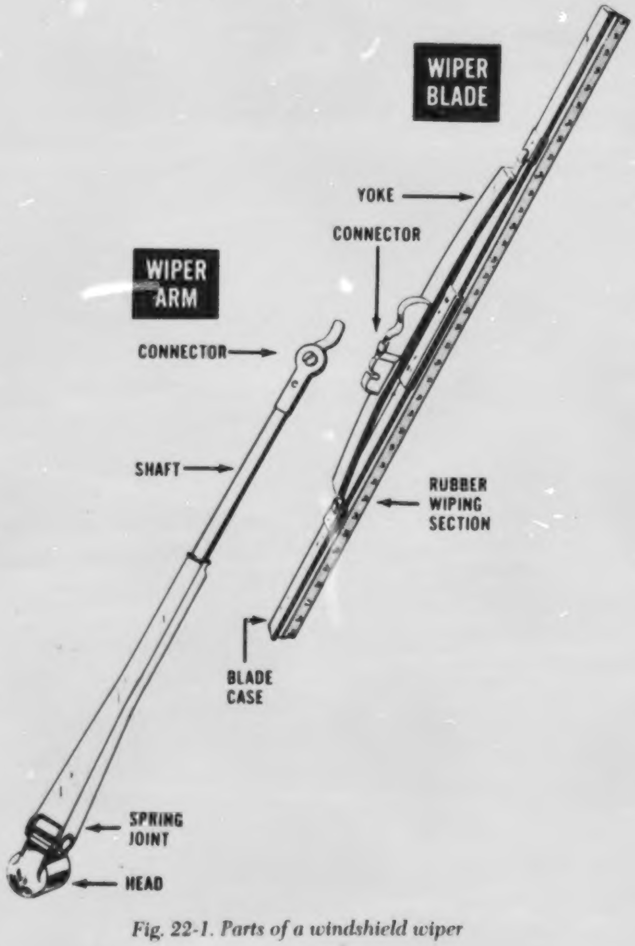


Fig. 22-1. Parts of a windshield wiper

tively. A part of the blade may break off or have a wavy appearance, leaving smudged, dirty streaks on the glass. Look for all these telltale signs of damaged, worn-out blades when you are making a routine service check of the car. Look for telltale smudged and streaked arcs where the windshield wipers travel across the glass. Look for bent arms and refill blades. Look for uneven tension where only a portion of the glass is being cleaned.

Routine Servicing

When cleaning the windshield, it is easy to check the condition of the wiper blades. Telltale streaks on the windshield are an obvious indication that the wiper blades are not doing a good cleaning job. Older models have the wiper blades and arms exposed so you can easily see the condition of the wiper assembly. Newer models that have the wiper arms and blades hidden under the cowl need a closer look. You can still pull the wiper arms upward on the new models and look closely at the rubber squeegee and the refill blade.

Replacement blades are inexpensive. If blades need replacing, show the condition to the customer and suggest a refill blade. It only takes a few minutes. To replace the wiper blade, you must know the length of the old blade, the type of attachment to the arm, and the manufacturer of the assembly. Anco and Trico are the major suppliers of windshield wiper equipment. Tridon is another supplier that may be found on some original equipment.

The length of the replacement blade is easily measured against the one being removed. Most critical is the type of **arm attachment.** It may be one of several different styles:

Bayonet type is a flat arm piece with a slight angle toward the outer end. It is commonly found on American-made vehicles with exposed wiper assembly. A small pin on the end of the arm secures the refill blade to the arm.

Side pin type is found on most American-made cars with hidden wiper assemblies. The end of the arm has a holder with a pin sticking from the side. The blade assembly snaps onto the pin.

Shepherd's crook is a flat arm that has the end turned under to form a crook on the end. It is found on many foreign-made automobiles. The wiper assembly snaps over the crook of the arm.

Wrist action type is also found on many foreign cars. It has a shallow curve or dip on the end that secures the wiper assembly.

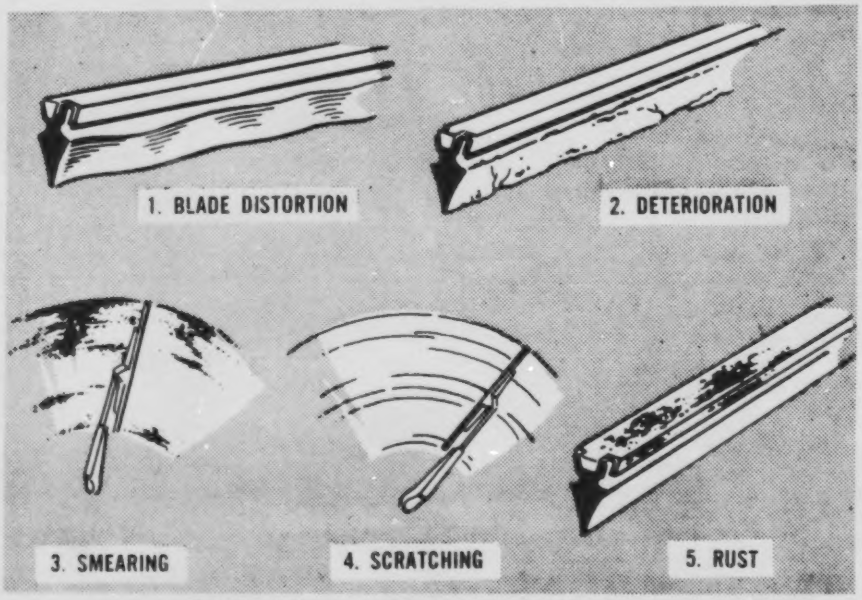


Fig. 22-2. What to look for when servicing wiper parts

On a few American-made cars, the wiper assembly and wiper arm are permanently locked together. On these, the entire wiper arm and blade assembly must be replaced. To remove the wiper arm, lift the wiper blade and arm all the way out and pull. The arm is attached to a small knurled shaft. On some models, you may find a small nut or bolt that secures the arm to the shaft, Remove this first before pulling out. A few models have the washer nozzle attached to the arm, and it must be disconnected before the entire assembly is removed.

Windshield Washer Systems

The washer system is made up of the fluid reservoir, the motor and pump assembly, connecting hoses, and spray nozzles. Some models of cars have a rear washer assembly. These are usually two separate assemblies, but they may use the same water reservoir. The pump assembly is mounted either next to the reservoir or on the firewall close to the wiper arms. Rubber or neoprene hoses connect the reservoir, pump, and spray nozzle. The washer switch is located on the wiper control and activates the wiper and washer at the same time. Most cars have a timed pulse or continuous spray pattern for about three or four complete sweeps of the wiper. Shutoff is automatic.

The major problem of washer assemblies is in the spray nozzle. The openings are very small and often get clogged with dirt, corrosion, and hard water minerals. Use a pin, fine wire, or similar device to open the hole in the end of the spray nozzles. Turn the switch on, and observe the spray pattern. The stream of water may be too high or too low and need adjustment by slightly bending the nozzle.

The reservoir needs periodic inspection and cleaning. Most reservoirs are either jars or plastic bags. Newer model vehicles have a plastic reservoir that resembles the one that holds the radiator coolant. Make sure you don't confuse the two. Adding antifreeze designed for the radiator to the reservoir that holds the washer fluid will ruin the car's finish. A special antifreeze is made for this purpose. Rou-

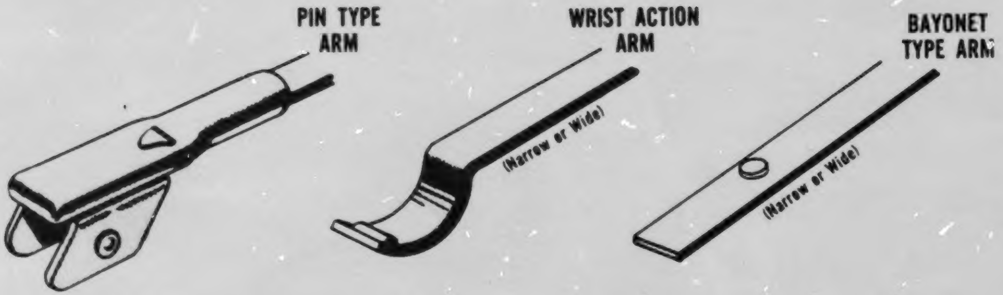


Fig. 22-3. Types of arm attachments

tine servicing requires adding fluid, or cleaning the reservoir if it looks dirty or muddy. A small filter screen is in the bottom, and low pressure usually means a clogged filter screen. Remove it for easy cleaning. In areas where hard water is used, it will clog frequently.

Inspect the connecting tubing for cracks, deterioration, kinks, or leaky connections. Replace damaged or worn tubing.

Questions

1. What are the major parts of the windshield wiper system?
2. What are the major parts of the windshield washer system?
3. Why do wiper blades require constant replacement?
4. How can you tell that a wiper blade needs replacing?
5. How is the washer system normally serviced?

23

All-around Safety

Objectives: After completing this assignment, you will be able to—

1. explain the need for safety-consciousness when working in and around petroleum products and
2. discuss safety practices and procedures when working with gasoline and motor fuels, service of vehicles, and tires.

Safety is not a set of rules of dos and don'ts. Safety is an attitude and a habit. Safety is not something you do once in a while or when you think of it. Safety is a constant awareness and something you practice all the time. You become safety-conscious out of training and the development of a safe attitude. Accidents are nonreversible—they cannot be undone. Once an accident happens, the results are immediate, and often permanent.

The petroleum marketing business is full of hazards because of the nature of the materials, tools, and equipment used. But hazards do not have to be frightening to you. If you recognize where the dangers are and recognize that safety is your constant 24-hour concern, then you can go about your work freely and with self-confidence.

All the information here is the result of many years of collective experience and knowledge. It is presented to you in this manner—that you will observe the rules and the laws, and that you will use extreme care when handling dangerous or hazardous materials, tools, and equipment. Common sense alone will tell you about obvious dangers. Other dangers may not be so obvious, so you need to read and study this assignment carefully.

Safe Handling of Gasoline and Motor Fuels

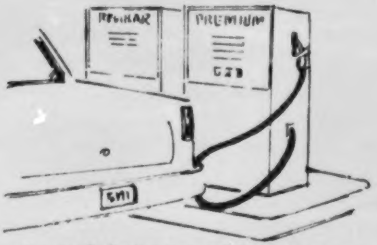
Gasoline as a liquid will not ignite. It is dangerous only in the form of vapor. Where gasoline is exposed to air, it will produce high volatile vapors that can be ignited by any flame, spark, or burning material such as the end of a cigarette or cigar. Safety in the handling of gasoline is the major concern of everyone. Your carelessness endangers not only your life, but also the lives of your co-workers and everyone else nearby. Fire is always disastrous because a gasoline fire destroys property and is difficult to control and put out. Not only are people seriously burned and injured, but the property loss usually results in loss of jobs and income for many.

Precautions in the Safe Receiving and Storing of Gasoline

- Make sure the right motor fuel goes in the right tank for storage.
- Keep fill caps tight. Use grease on the threads to make them waterproof.
- Use a gauge stick to measure the level before delivery so the tank will not overflow.
- Use indicator paste on the gauge stick to see if water has accumulated, then remove the water before more gasoline is put into the tank.
- Make sure no vehicles are in the area where the tanks are being filled.
- Vapors from vent pipes should be well above building level and have no chance of entering an open window or ventilator.
- Prohibit smoking, sparks, or open flame when tanks are being filled because vapors are being discharged from the vent pipes during fill.
- Check vent pipes to make sure no gasoline liquid is being discharged.

Precautions When Using and Pumping Gasoline

- Never smoke or permit smoking at the gasoline pump island.
- Never use gasoline as a solvent to wash away grease and oil accumulations.
- Keep gasoline away from hot manifolds and auto engines. When servicing or removing gas lines and connections, make sure the liquid will not spill onto hot surfaces.
- Put gasoline only into approved containers or fuel tanks of vehicles.



Loops in hoses can catch on bumpers.

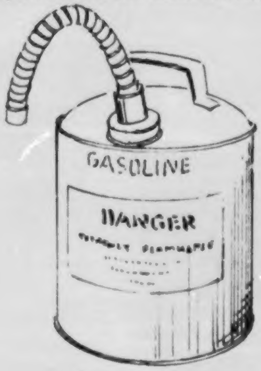


Figure 23-1

- Never store gasoline in any container that is open or improperly vented.
- Never store gasoline inside a building or closed place where vapors might accumulate.
- Gasoline is intended only as a motor fuel. Use it and dispense it that way, and you will always be safe.

Safety in the General Service of Vehicles

- Approach the cars in a service area carefully. Make sure they are stopped, and never step in front of a moving vehicle.
- Never open a car door without first checking inside; a child may fall out.
- Watch out for passenger's hands and feet when closing a car door.
- Make sure a hood will remain in an upright position before you release it.
- Never try to work in and around the radiator or front part of the engine with the engine running; you may get caught in the fan belts.
- When removing or installing fan belts, remove the ignition keys so that no one will accidentally start the engine.
- When removing small light bulbs, use a cloth to protect your hands from possible broken glass.
- Use a compressed air gun carefully. Never point it at anyone or direct the air stream toward yourself.
- Wipe up oil, grease, and gasoline spills immediately.
- Make sure that the hand brake is set or transmission is in gear to prevent a vehicle from moving when you are working underneath or under the hood.
- Keep your clothing and shoes free of grease and oil—always have a sure grip.
- Do not lift heavy objects without assistance or use of proper equipment.
- Always keep your body straight, and bend from the waist without twisting or being off balance.
- Keep knees bent and back straight when lifting from the floor. Keep load close to body and use legs to lift—not your back.
- Get help in pushing a stalled vehicle; never try to push it by yourself.
- Keep pump hoses secure; make sure they do not catch on bumpers.
- It is best to hold an automative nozzle securely in the tank fill opening.

Safety in Radiator Service

- All modern engines have a pressure system. Use extreme caution when removing radiator fill caps.
- Place a heavy cloth on top of the cap before attempting to turn it. Turn only a quarter-turn counterclockwise to let pressure escape.
- If you hear a rumbling noise, or coolant begins to spew, close the cap immediately and let the radiator cool.
- After pressure is released, turn the cap fully to remove, and check the fill level.
- Make sure the cap is turned completely closed when service is completed.
- Operate engine at idle while filling radiator with coolant. This allows the coolant to circulate quickly and prevent damage to inner parts.
- Alcohol-type antifreezes should be used and poured outdoors only. Store alcohol products the same as gasoline.
- If antifreeze soaks the clothing, remove the clothing as quickly as possible, and launder before wearing again. Wash down affected parts of the skin.
- Check radiator and cooling system for possible leaks in hoses and connecting clamps. Also, check radiator for signs of a leaking core or tank.

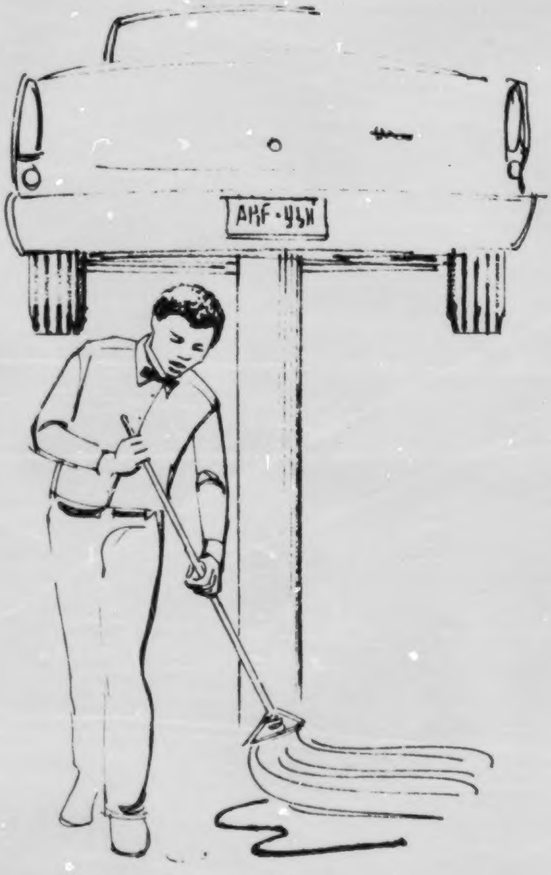


Figure 23-2

Safety in Tire Service

- Tires can be dangerous unless treated properly during service, removal, and reinstallation.
- Use a pressure gauge. Look for damage that might cause a tire to blow out when filling with air.
- Use gloves when inspecting the outside surfaces of tires, particularly those that have steel belts. Worn tires may have small steel wires sticking out over the sidewall surfaces. Others may have imbedded glass, nails, or metal.
- Protect yourself from blowout when filling tires. Stand to one side so that the fender is between you and the tire.
- Use extra precaution in servicing truck tires. Use the safety devices, and make sure the lock ring on the rim is secure. Never put your hand between dual tires when inflating them.
- When balancing tires, keep hands, arms, and legs away from spinning wheels.
- Do not use a balancer on the rear wheels. Make sure the car is properly jacked and secured before starting the balancing process.

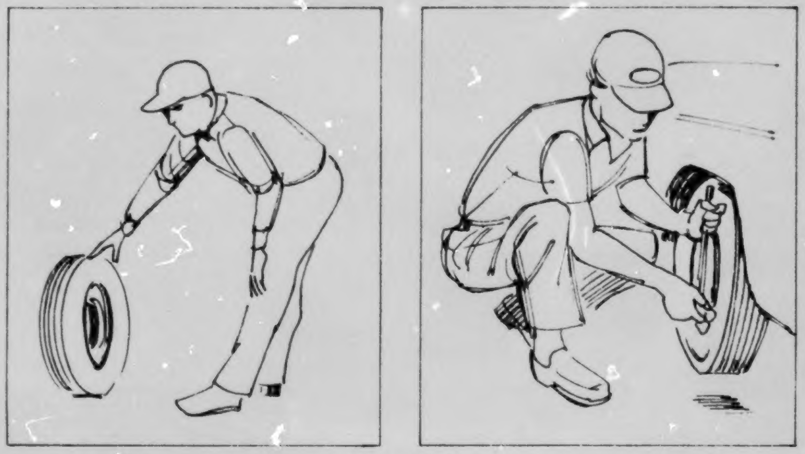


Figure 23-4

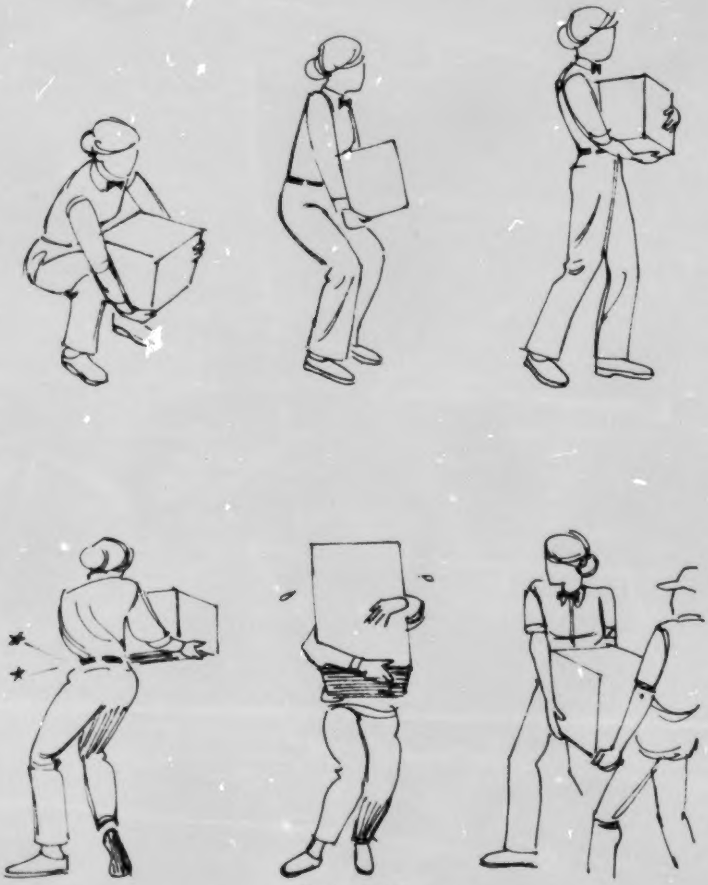


Figure 23-3

Safety in Battery Service

- Never smoke or permit smoking around a battery. The hydrogen gas is highly explosive. Treat batteries like they were filled with gasoline instead of acid.
- Wipe up and flush water onto any acid spills. Remove clothing immediately, and flush skin with water wherever acid has spilled. Flush car parts and surfaces liberally with water to neutralize acid.
- Use a baking soda solution to remove corrosion on battery tops and surrounding parts.
- Recharge batteries outside or only in well-ventilated rooms.
- When installing a battery, attach the ground wire last. Remove the ground wire first when removing a battery.
- Batteries are heavy Use a battery carrier to lift a battery from its holder or when installing one in a vehicle. Lift a battery properly so that you do not strain your back.

Safety in the Service Bay Area

The service bay is perhaps the most dangerous area in which to work. You should recognize where hazards exist and use your safety-consciousness when you are working there or just walking through. These are good rules to observe:

- Always clean up oil and grease immediately.
- Never play or aimlessly point a pressure grease gun at yourself or anyone else.

- Do not rock a car that is hoisted on a free wheel lift. The movement can cause the car to shift weight and possibly fall from one support.
- Do not let the engine run on a vehicle in a closed service bay unless you have a proper hose connection to the tail pipe exhaust system. Carbon monoxide can accumulate in sufficient amount to poison or cause serious injury and possible death.
- Do not overload a hoist lift. Most are designed only for passenger cars or light trucks.
- Do not allow anyone to remain inside a vehicle when it is hoisted on a lift.
- Keep your hands on the control valve while the lift is being raised. Do not prop it in the open position.
- Do not allow anyone to walk under the vehicle while it is being hoisted. Wait until the safety lock is in position before working underneath.
- Report faulty equipment immediately. Do not try to use any piece of service equipment that is not operating properly.
- Keep all tools in their proper place. Never leave any tool or piece of equipment on the floor where it will trip someone.
- Never keep a hydraulic hoist in the up position when not in use.
- If a vehicle has curb feelers, tie a cloth or rag on each one to lessen the possibility of eye injury.
- If the bay has a service pit, it should be unoccupied when driving the vehicle into position.

Figure 23-5

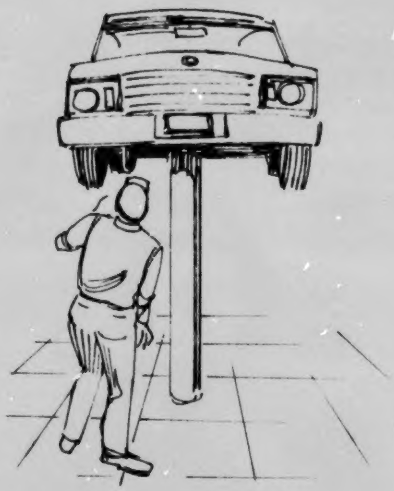


Figure 23-6

- Service pit steps are extremely hazardous. Keep all oil and grease spills wiped clean, and never leave tools or equipment on the steps.
- A safety chain or other device to bar the entryway into a pit should be in place at all times when the pit is not in use.

Where a service bay is equipped with a frame contact or free wheel hoist lift, observe these safety rules:

- Center the vehicle over the lift. Use a second person to guide you.
- Make sure the adapters are properly adjusted to fit the frame at the right contact points and that all four are in place.
- Raise the lift off the floor, and stop it just before it makes contact with the vehicle. Inspect underneath to make sure the muffler, tail pipe, catalytic converter, transmission, or any other part will not be damaged on the lift.
- Raise the lift until contact is made. As the car is being raised, check underneath to see that the four adapters are in place and holding as they should. If a slight adjustment is needed, lower the vehicle and make the adjustment while it is resting on its wheels.
- Never rock a vehicle on this kind of lift.

Safety in the Use of Tools and Equipment

- Use only approved solvents for cleaning tools and equipment. Never use gasoline, kerosene, or other combustible liquids.
- Use solvents only in a well-ventilated area, and try to avoid inhaling the vapors. Wash hands and wrists thoroughly with soap and water afterwards to neutralize solvent on the skin.
- A solvent tank works best when half-filled with water. The solvent remains on top of the water, but the grease, dirt, and foreign particles sink to the bottom, leaving the solvent clean.
- Never smoke or use open flames around any cleaning materials.
- Use tools properly and only for their intended use. Never use a defective tool or one that is in need of repair.
- Power equipment should only be used by persons experienced in their operation. Inspect cords and plugs to see that there are no loose or exposed wires.
- Safety devices on tools and equipment are designed to be used—never bypassed.
- Adjustable wrenches should be free of oil and grease. Adjust for a snug fit, and have a firm footing when applying pressure.
- Always return tools and equipment to their proper storage place immediately after use.
- Air compressors need regular inspection and maintenance. Turn off the main switch before inspecting, oiling, wiping, or working on the compressor.
- Check the safety valve every week for proper operation.
- Never tamper or try to adjust safety valves and controls. Repairs should be made only by authorized service personnel.
- Do not let any boxes, cartons, tools, or equipment rest anywhere near a compressor. A shift can cause them to fall into and damage the compressor.
- Inspect any ladder before use. Never use a ladder that is damaged or unsteady or has missing parts. Never use boxes or cartons in place of a ladder.
- Never put a ladder in front of a door or entryway unless it is locked or guarded.
- Never use a stepladder except in a fully opened position. Never stand

on the top rung of a stepladder or on the very top support. It is always best if a second person holds or steadies any ladder while it is in use.

- Check all electrical equipment on a regular basis. Check switches, plugs, cords, and safety devices. All electrical equipment should use only a three-wire cord and plug, or a grounding device.
- Never replace a fuse with one that is larger or of greater amperage than it should be. Fuses are safety devices to prevent overload, shorts, and fires.
- Never overload an electrical circuit. Avoid using multiple-outlet devices.
- Use extension cords of the right size. A cord that is too small will overheat and burn out. It will also reduce the voltage to the appliance and cause its motor to burn out.

General Fire Safety

Fire is always a special problem around petroleum products. Fires can start easily around automobiles, either from spilled gasoline or from electrical shorts. Fires can easily start wherever combustible materials are stored. You should know how to dispose of wastes, oily rags, solvents, and similar materials that can cause combustion.

- Report and discontinue use of a gasoline pump that leaks.
- Never pour gasolines, solvents, alcohol, or other combustible liquids into a sewer or drain.
- Never use combustibles or wastes to start a fire in a wood-burning or coal-burning heater.
- Inspect hot-air and gas-burning heating devices regularly.
- All room heaters and hot water heaters should be installed overhead, or in a protected area where no other materials are stored.

In case of fire, you should know what to do immediately. Follow these rules:

- Know the location of all fire-fighting equipment and how to use it.
- Call the fire department immediately, or have someone call while you try to extinguish or control the fire.
- A fire in or around a vehicle should be extinguished immediately. If the fire spreads rapidly and is out of control, get everyone away from the burning vehicle into a safe area.
- A gasoline fire must be extinguished at its base, using a dry chemical extinguisher that smothers the flame. Use a rapid side-to-side motion to get the flame completely out. If you don't, the fire will start again.
- Never use water on any fire unless it is burning trash, paper, wood, or grass.
- Once the fire is out or under control, call the insurance company and give a complete report.

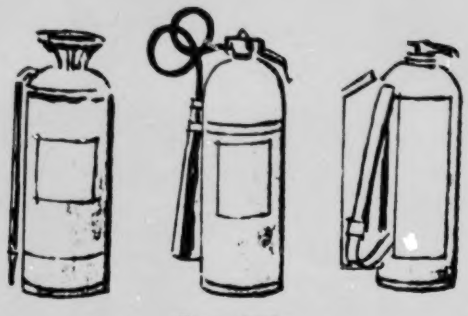


Figure 23-7

First Aid

- Keep first-aid kits in a convenient place and where they are easily used.
- Refill and replace first-aid supplies on a regular basis.
- Know how to treat wounds, cuts, and gasoline and acid spills.
- Know how to render aid to persons suffering from smoke inhalation, fumes, and carbon monoxide poisoning.
- Know how to render first aid for burns.
- Know how to render first aid for electrical shock.
- Know how to treat eye injuries.
- Get medical help to victims as soon as possible.
- Report all injuries and accidents to the owner and the insurance company.
- If a customer or bystander is injured, get the person's name and address, if possible. Get the names and addresses of witnesses to accidents and injuries.

Questions

1. In your own words, explain "safety-consciousness."
2. When you are working in a hazardous environment, how can you have a good attitude toward your job?

Projects

1. Draw a simple sketch of a floor plan of your training station. Place a red *X* on the sketch to show the location of all pieces of fire-fighting equipment, including fire extinguishers and fire hoses, if any. Use a blue *X* to locate the first-aid kit or first-aid station at your training station.
2. If your training station has underground gasoline and motor fuel storage tanks, give (1) the procedures used to (a) receive gasoline and motor fuels from a carrier and (b) check the tanks before and after delivery and (2) the safety precautions in the receiving and storing of these liquids.
3. If your training station services and repairs truck tires, tell what safety equipment is used, and explain in detail how each device works.
4. If your training station has a service bay area for vehicles, draw a sketch of the floor plan, showing the location of (1) hydraulic lift(s), (2) air compressor, (3) tool and equipment storage, (4) first-aid kit, and (5) fire-fighting equipment.

24

Selling Automotive Services

Objectives: After completing this assignment, you will be able to—

1. explain the value to both the customer and the business when automotive services are sold;
2. name two methods that can be used to find and recommend needed services to the customer; and
3. name the twelve systems that need inspection on a regular basis.

With the exception of two or three basic services, most motorists and car owners seldom ask or think about other needs. Most will ask for oil changes, lubrication, and tune-ups. Even so, many do not ask for them on time, but usually wait until the need is called to their attention.

Your customers actually depend on you to recommend basic automobile services. Services are vital to a vehicle's performance and troublefree operation. More than that, services provide a better margin of profits for a business than selling products. So, when you sell or recommend services, you do the customer a favor and you do the business a favor. Both mutually benefit from a strong selling approach to services.

As an extra motivation, you should be aware that as long as you are in the automobile service and product business, you have a responsibility to the car owner. Your responsibility is to make the customer aware of needed services and replacement parts. This is particularly true with systems such as brakes and exhaust where the owner's safety is involved. However, your responsibility is also to service those systems that may cause inconvenience and unnecessary delay if neglected.

All illustrations in this assignment are provided courtesy of Mobil Oil Corporation.

Good business is providing good service and building customer relations. You make money only from repeat business and loyal customers. Profits, and the ability to stay profitable, come from having many satisfied car owners who trust you and depend on you to tell them what they need.

Every new car and truck comes with an owner's manual that specifies the required and recommended services and when they should be done. Few car owners pay much attention to that information, so it is up to the service business to do it. For the first year or first 10,000 miles, most automotive systems do well, but after that the systems decline rapidly. Unless properly serviced, the car's useful life is greatly diminished.

You find and recommend needed services by one of two methods: (1) a complete inspection each time the car is brought in for any service or (2) maintaining service records on each customer. For regular customers, the latter method is much preferred. For other customers, the inspection method is necessary. You sell services by finding the need and then recommending the needed service or part. You can build a good clientele by encouraging customers to let you keep a service record and take care of needs as they arise.

The **inspection routine** is time-consuming, but it pays off in increased business. It requires training and a commitment on the part of service personnel. Each time a car is brought in for routine service, such as an oil change or lubrication, then you perform a thorough system inspection. It includes inspecting each of the following systems:

Fuel system—including carburetor, air filter, automatic choke assembly, fuel filter, accelerator linkage, and fuel pump (fig. 24-1).

Starting system—including starter motor, solenoid, battery, battery cables, and battery holddown assembly (fig. 24-2).

Ignition system—including the distributor, points, condenser, spark plugs, ignition wires, and ignition coil (fig. 24-3).

Charging system—including generator or alternator, regulator, and drive belts (fig. 24-4).

Cooling system—including radiator, hoses, heater hose, radiator pressure cap, fan blades and fan shroud, fan belt, and transmission oil cooler lines (fig. 24-5).

Lubrication system—including oil filter, oil dipstick, automatic transmission fluid dipstick, valve cover gaskets, crankcase pan gaskets, and PCV valve as well as carbon canister

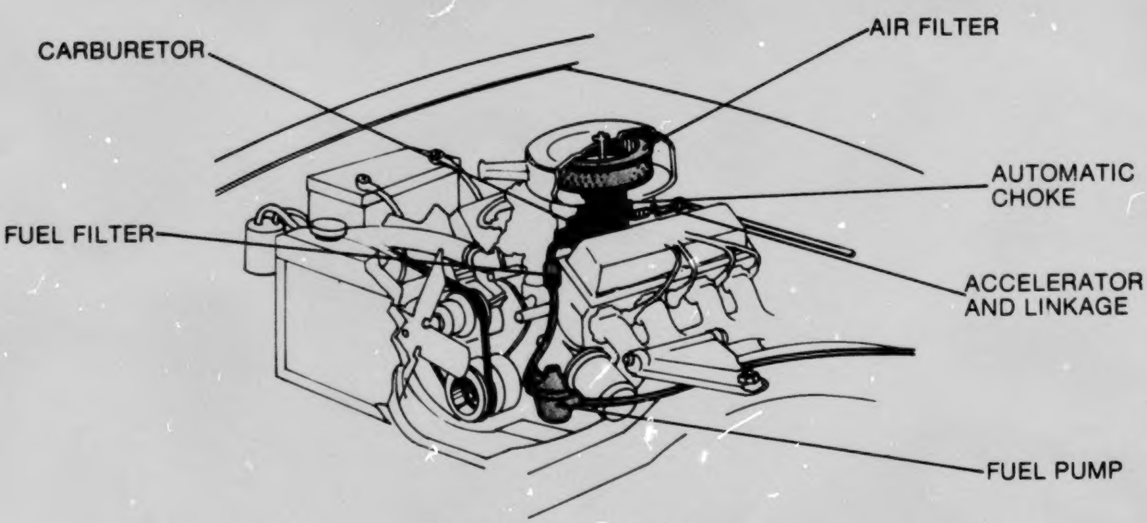

CARBURETOR
AIR FILTER
AUTOMATIC CHOKE
FUEL FILTER
ACCELERATOR AND LINKAGE
FUEL PUMP

Fig. 24-1. Check the fuel system.

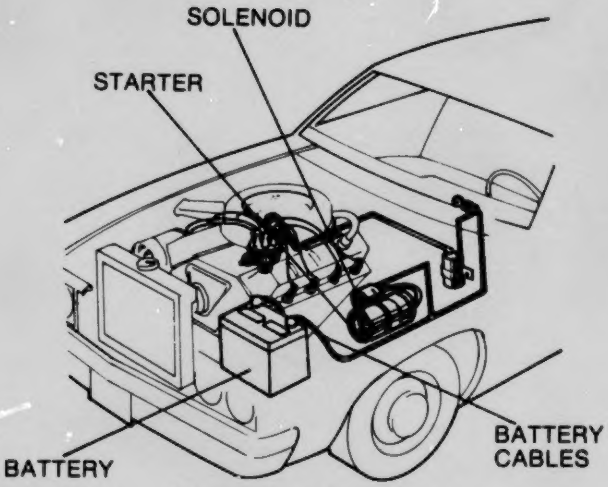

SOLENOID
STARTER
BATTERY
BATTERY CABLES

Fig. 24-2. Check the starting system.

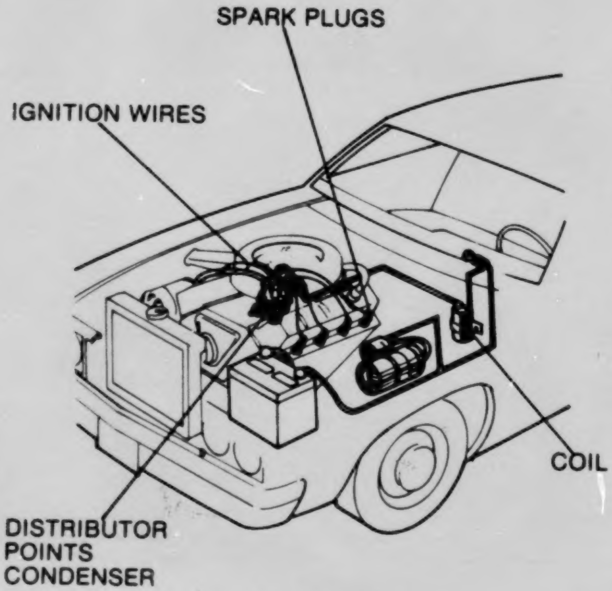

SPARK PLUGS
IGNITION WIRES
COIL
DISTRIBUTOR
POINTS
CONDENSER

Fig. 24-3. Check the ignition system.

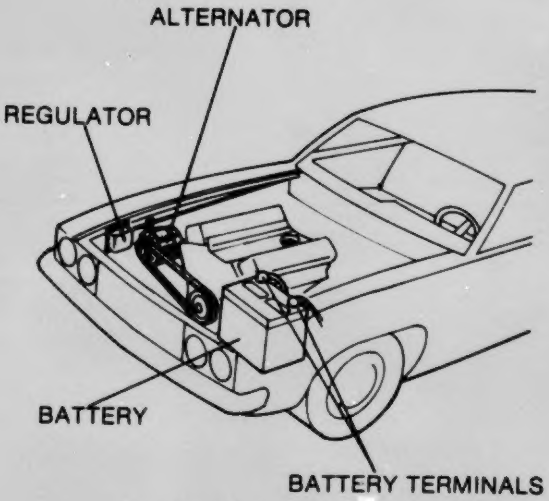

ALTERNATOR
REGULATOR
BATTERY
BATTERY TERMINALS

Fig. 24-4. Check the charging system.

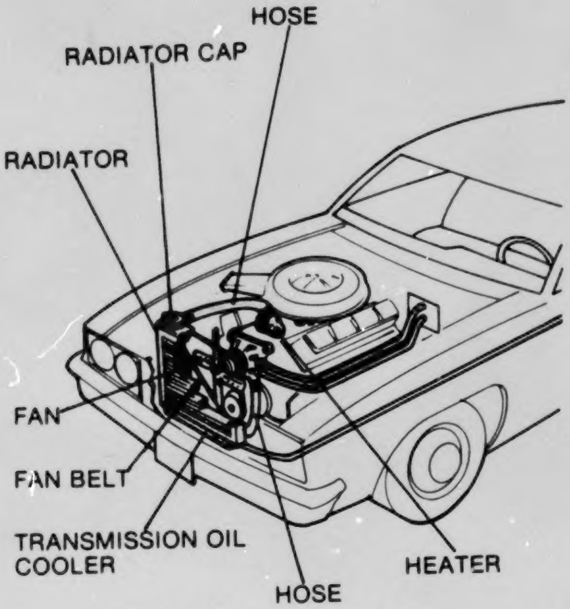

HOSE
RADIATOR CAP
RADIATOR
FAN
FAN BELT
TRANSMISSION OIL COOLER
HOSE
HEATER

Fig. 24-5. Check the cooling system.

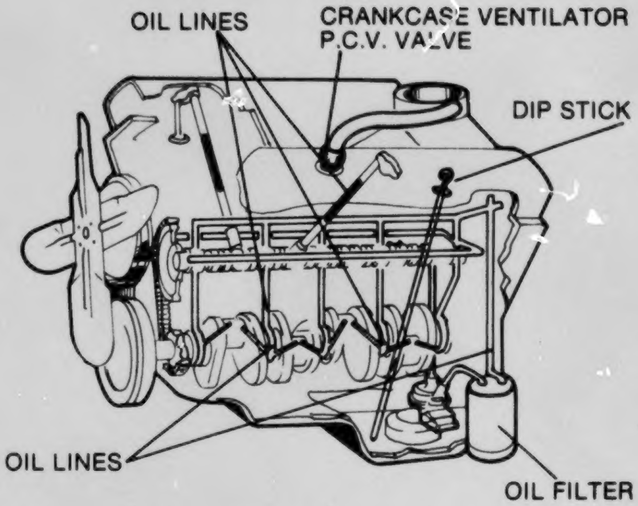

OIL LINES
CRANKCASE VENTILATOR P.C.V. VALVE
DIP STICK
OIL LINES
OIL FILTER

Fig. 24-6. Check the lubrication system.

filter and connecting PCV and emission control hoses (fig. 24-6).

Drive system—including wheel bearings, universal joints, and differential (fig. 24-7).

Suspension system—including front-end lubrication points, torsion bar, shock absorbers, upper and lower control arms, kingpins, ball joints, and steering mechanisms (fig. 24-8).

Steering system—including power steering pump, control arms, tie rods, and drag linkage (fig. 24-9).

Brake system—including front disc or drum brake shoes and pads, wheel cylinders, master cylinder, brake fluid reservoir, fluid lines, parking brake cable and linkage, and power brake assembly (fig. 24-10).

Exhaust system—including manifolds and gaskets, muffler, catalytic converter, exhaust and tail pipes, and all hangers and brackets (fig. 24-11).

Safety system—including windshield wipers, blades, washer spray nozzles, fluid reservoir, hoses, pump, and electrical, such as headlamps, brake and tail lamps, blinker system or turn signal system, and parking lamps.

The service record system is the recommended method of keeping customers coming back and taking care of their service needs. Cars serviced on a regular basis seldom have mechanical difficulties or emergencies. The vehicles last longer and perform better. The difference is that regular maintenance must be *sold.* Your job is to tell customers why a regular maintenance schedule and record system is best for them. You should show the record system and how it works for the customer's best interest. Regular maintenance and service pays in the long run and costs less than unexpected and emergency repair bills.

A *customer service record* is a form that has the customer's name, address, telephone numbers, make and model of car (a separate record for each car) along the top portion (fig. 24-12). Below that is a chart that shows the various products and services, date, mileage, and time for next service. Each month the service records are reviewed, and those that have needed

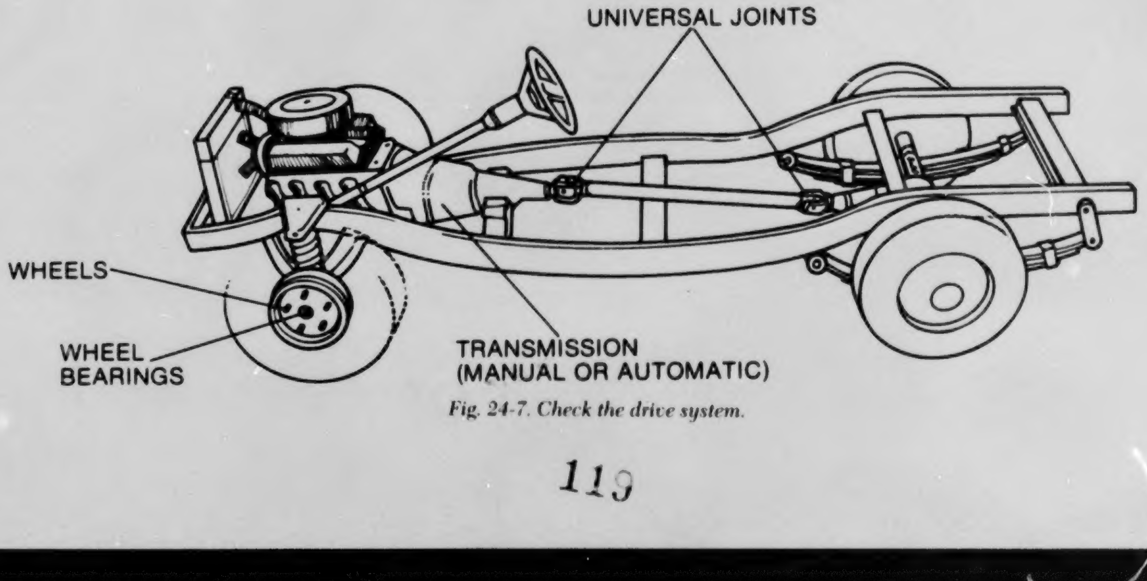

UNIVERSAL JOINTS
WHEELS
WHEEL BEARINGS
TRANSMISSION (MANUAL OR AUTOMATIC)

Fig. 24-7. Check the drive system.

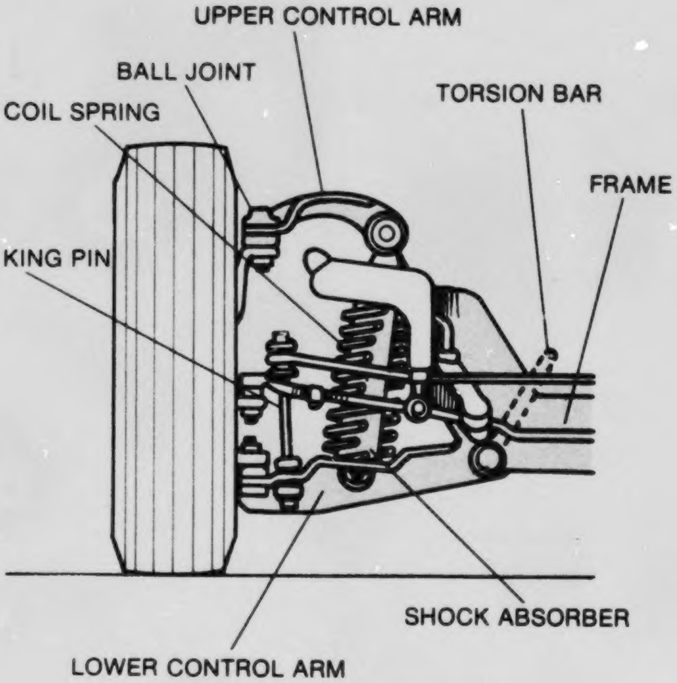

UPPER CONTROL ARM
BALL JOINT
COIL SPRING
TORSION BAR
FRAME
KING PIN
SHOCK ABSORBER
LOWER CONTROL ARM

Fig. 24-8. Check the suspension system.

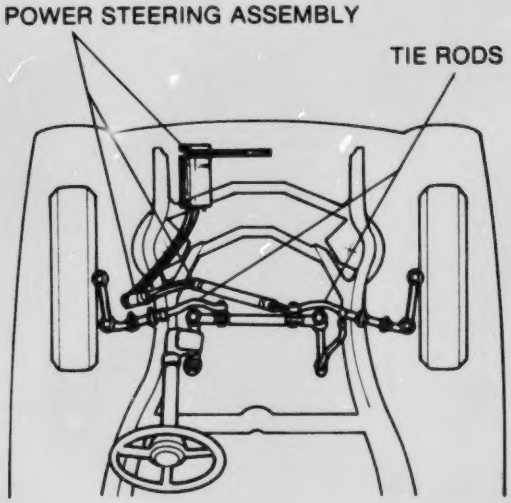

POWER STEERING ASSEMBLY
TIE RODS

Fig. 24-9. Check the steering system.

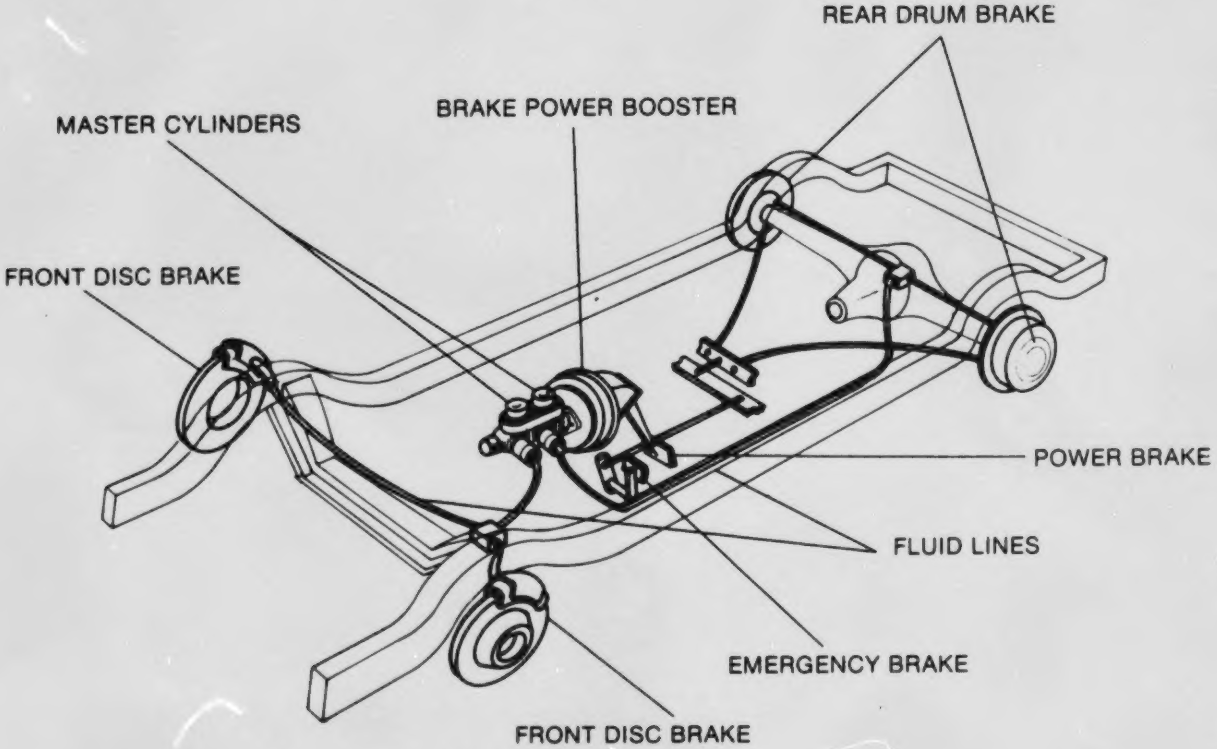

REAR DRUM BRAKE
MASTER CYLINDERS
BRAKE POWER BOOSTER
FRONT DISC BRAKE
POWER BRAKE
FLUID LINES
EMERGENCY BRAKE
FRONT DISC BRAKE

Fig. 24-10. Check the brake system.

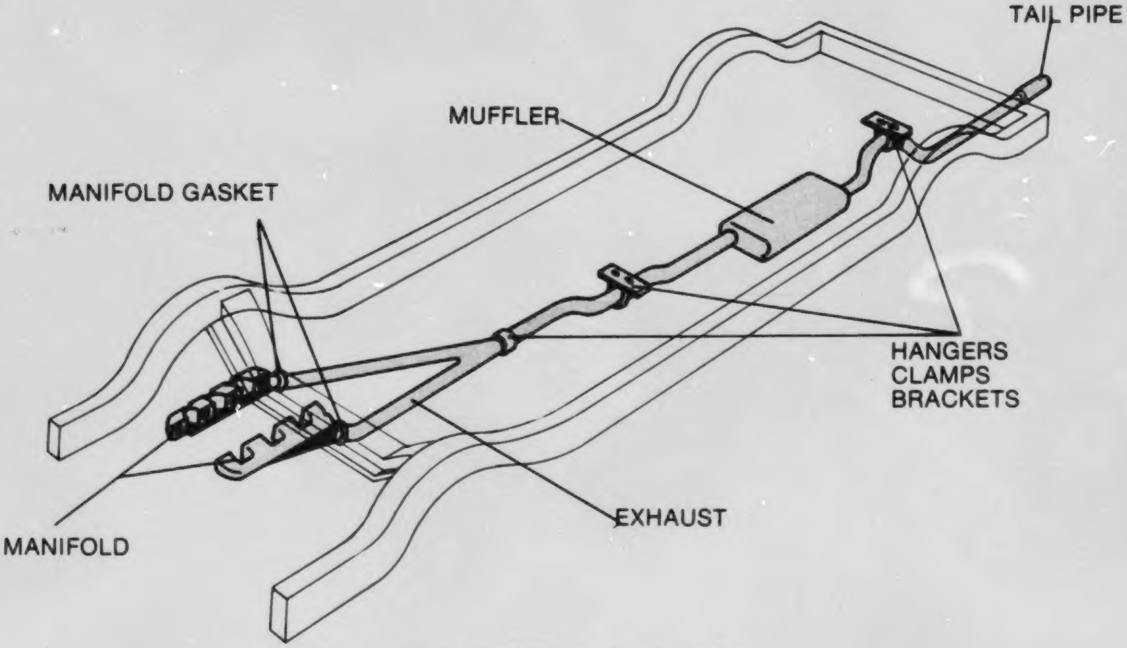
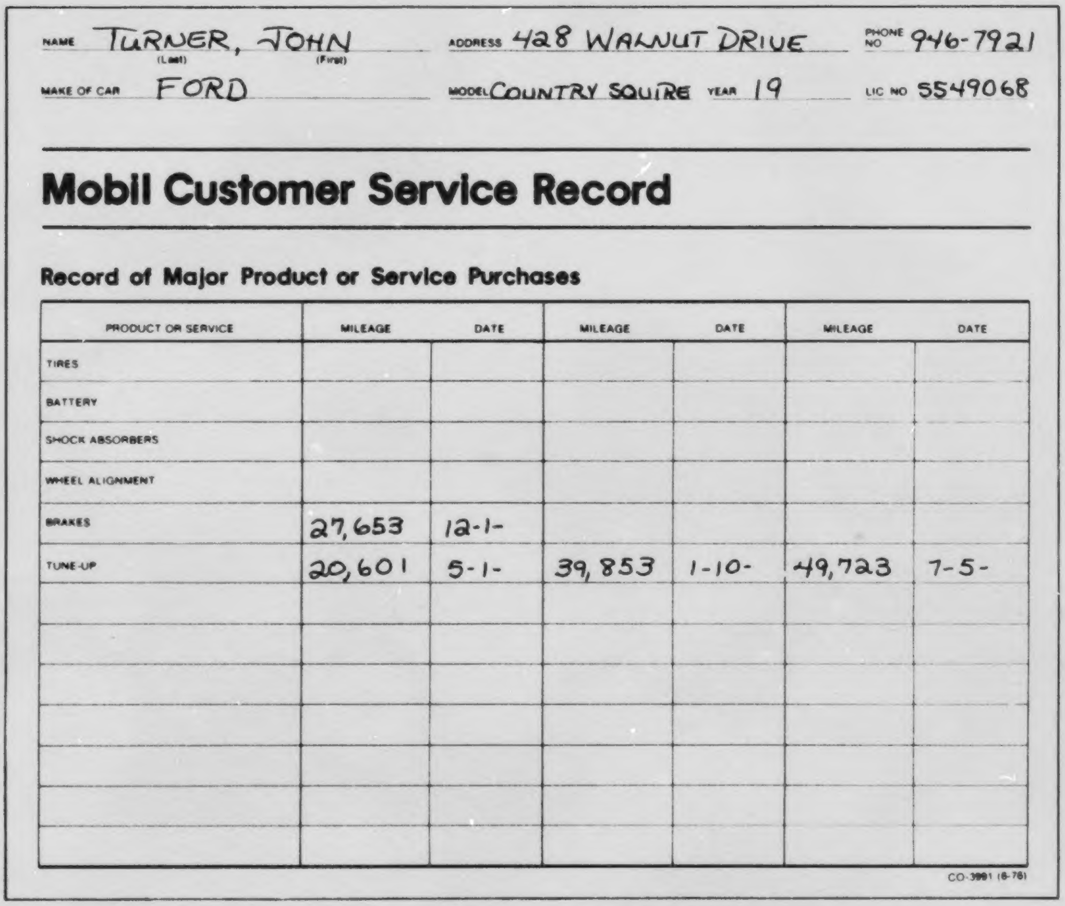

TAIL PIPE
MUFFLER
MANIFOLD GASKET
HANGERS
CLAMPS
BRACKETS
EXHAUST
MANIFOLD

Fig. 24-11. Check the exhaust system.



NAME TURNER, JOHN (Last) (First) ADDRESS 428 WALNUT DRIVE PHONE NO 946-7921

MAKE OF CAR FORD MODEL COUNTRY SQUIRE YEAR 19 LIC NO 5549068

Mobil Customer Service Record

Record of Major Product or Service Purchases

PRODUCT OR SERVICE	MILEAGE	DATE	MILEAGE	DATE	MILEAGE	DATE
TIRES						
BATTERY						
SHOCK ABSORBERS						
WHEEL ALIGNMENT						
BRAKES	27,653	12-1-				
TUNE-UP	20,601	5-1-	39,853	1-10-	49,723	7-5-

CO-3991 (6-76)

Fig. 24-12. The customer service record is a document for keeping customer needs on file.

services due are pulled and put into a special date file. The customers are either called by telephone or sent a postcard reminding them that services are due. Give customers a date or appointment, and make them feel that a special time has been reserved for them. This system keeps work coming in on a steady basis and keeps customers constantly reminded of needed services.

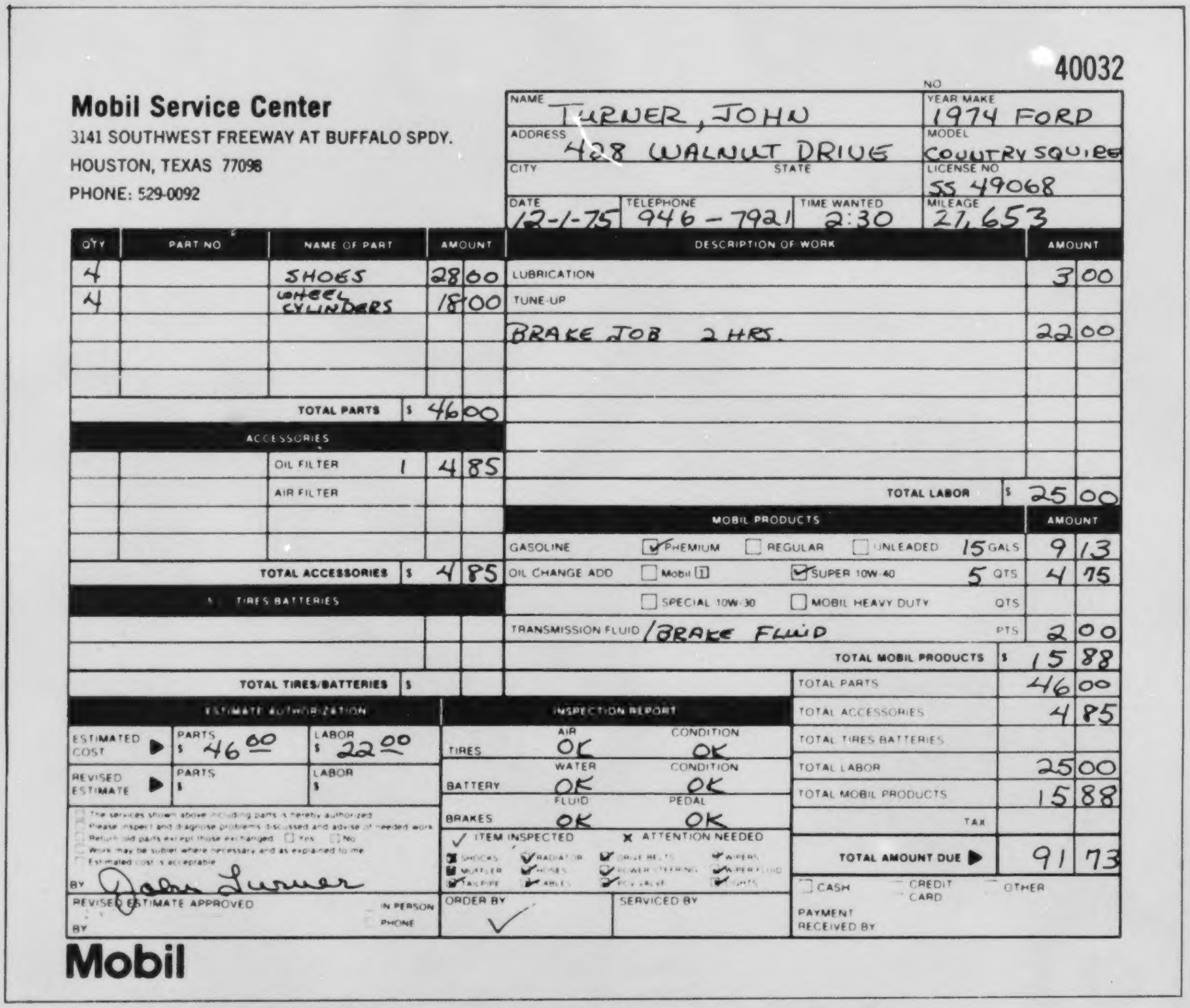
There are additional benefits from such a system. It helps tremendously to maintain good customer relations. In handling complaints, you have a complete record of when parts were installed and the price charged and mileage and dates when services were performed, and who did the work. You can make any necessary allowances and adjustments, or you can show the customer how the work was handled.

A *service order* or *job ticket* is a form that shows the products, services, charges, mileages, and dates of work done on a customer's car (fig. 24-13). This information is transferred to the customer service record. The service order or job ticket is also used for accounting and inventory purposes, payroll information, and personnel or work performance records. It shows the actual work ordered and authorized by the customer, the parts, charges, labor charges, and a full description of the repair work performed or services performed. It shows which employee did the work.

Look at the two forms shown in figures 24-12 and 24-13. On the service order or job ticket, a complete brake overhaul job was performed on the customer's car at 27,653 miles. This information is transferred to the customer's permanent service record. When the customer comes in for a tune-up at 49,723 miles, a glance at the service record shows that the brake job now has 22,000 miles on it. It is time for a complete inspection of the brake system to see how the brakes are wearing. Adjustments may be all that is needed, or another brake overhaul order may be needed in a month or so.

Questions

1. For what reasons should automobile services be sold to customers?



NO 40032

Mobil Service Center
3141 SOUTHWEST FREEWAY AT BUFFALO SPDY.
HOUSTON, TEXAS 77098
PHONE: 529-0092

NAME TURNER, JOHN
ADDRESS 428 WALNUT DRIVE
CITY
STATE
DATE 12-1-75
TELEPHONE 946-7921
TIME WANTED 2:30
YEAR MAKE 1974 FORD
MODEL COUNTRY SQUIRE
LICENSE NO SS 49068
MILEAGE 27,653

QTY	PART NO	NAME OF PART	AMOUNT	
4		SHOES	28	00
4		WHEEL CYLINDERS	18	00
		TOTAL PARTS	$ 46	00

ACCESSORIES			
OIL FILTER	1	4	85
AIR FILTER			
TOTAL ACCESSORIES		$ 4	85

TIRES BATTERIES		
TOTAL TIRES/BATTERIES	$	

DESCRIPTION OF WORK	AMOUNT	
LUBRICATION	3	00
TUNE-UP		
BRAKE JOB 2 HRS.	22	00
TOTAL LABOR	$ 25	00

MOBIL PRODUCTS					AMOUNT	
GASOLINE	☑ PREMIUM	☐ REGULAR	☐ UNLEADED	15 GALS	9	13
OIL CHANGE ADD	☐ Mobil 1	☑ SUPER 10W-40		5 QTS	4	75
	☐ SPECIAL 10W-30	☐ MOBIL HEAVY DUTY		QTS		
TRANSMISSION FLUID /BRAKE FLUID				PTS	2	00
TOTAL MOBIL PRODUCTS					$ 15	88

TOTAL PARTS	46	00
TOTAL ACCESSORIES	4	85
TOTAL TIRES BATTERIES		
TOTAL LABOR	25	00
TOTAL MOBIL PRODUCTS	15	88
TAX		
TOTAL AMOUNT DUE ▶	91	73

☐ CASH ☐ CREDIT CARD ☐ OTHER
PAYMENT RECEIVED BY

ESTIMATE AUTHORIZATION

	PARTS	LABOR
ESTIMATED COST ▶	$ 46.00	$ 22.00
REVISED ESTIMATE ▶	$	$

☐ The services shown above including parts is hereby authorized
☐ Please inspect and diagnose problems discussed and advise of needed work
☐ Return old parts except those exchanged ☐ Yes ☐ No
☐ Work may be sublet where necessary and as explained to me
☐ Estimated cost is acceptable
BY John Turner

REVISED ESTIMATE APPROVED ☐ IN PERSON ☐ PHONE
BY

INSPECTION REPORT

TIRES	AIR OK	CONDITION OK
BATTERY	WATER OK	CONDITION OK
BRAKES	FLUID OK	PEDAL OK

✓ ITEM INSPECTED ✗ ATTENTION NEEDED

☒ SHOCKS	☑ RADIATOR	☑ DRIVE BELTS	☑ WIPERS
☒ MUFFLER	☑ HOSES	☑ POWER STEERING	☑ WIPER FLUID
☑ TAILPIPE	☑ CABLES	☑ PCV VALVE	☑ LIGHTS

ORDER BY ✓
SERVICED BY

Mobil

Fig. 24-13. The work order authorizes services, and the information is transferred to the service record.

2. What two methods can be used to find and recommend needed services to the customer?
3. Which automobile systems need inspection on a regular basis?

Projects

Complete one of these.

1. Make a chart based on an inspection of the twelve basic systems mentioned in the text. Beside each system, list the products and services your training station sells. For example, beside lubrication system, you might list motor oil, oil filters, and PCV valves, and that your training station drains, refills, and replaces these items. Or, beside brake system, you might list that your training station does *not* sell or service any brake system parts—only inspection is provided.
2. Using the two customer service record forms as examples, design a customer service and reminder file system for your training station. Explain how the system would work, and how you would organize the information so that customers would be notified of needed services when they come due. You can prepare a sample form, or simply explain in detail how the forms would be used and what information would appear on them.

25

Air-Conditioning Service

Objectives: After completing this assignment, you will be able to—

1. explain briefly how the air-conditioning system operates to provide cool air;
2. identify the component parts of an automotive air-conditioning system;
3. describe how to visually inspect the system; and
4. describe three methods of testing for leaks.

The Automotive Refrigerant System

How It Works

The air-conditioning system in an automobile works exactly the same as an air-conditioner or refrigerator in the home. All have the same component parts and refrigeration cycle.

In a cool-air distribution system, warm air is picked up inside the automobile and is transferred to the outside. The warm air is replaced with cooled, dry air. Comfort comes from a reduced temperature and reduced humidity or moisture.

In the automotive system, a compressor pumps a refrigerant into an evaporator coil. When the refrigerant is put under pressure, it changes to a liquid and begins to boil. While it boils inside the evaporator, it picks up heat from the air. The heat causes the refrigerant to change back into a gas, and it is pumped to the condenser coil. Here it loses the heat and returns to the compressor to be recycled again. All refrigerant systems are closed so that the cycles are continuous. The refrigerant itself is compressed and then relieved of pressure continuously so that it picks up heat and transfers it to the outside air.

The Component Parts

The major parts of the automotive air-conditioning system are these: *Condenser coils* are located in front of the radiator. A *receiver-dryer* tank rids the *refrigerant* of moisture. A *compressor* is driven by a belt from the

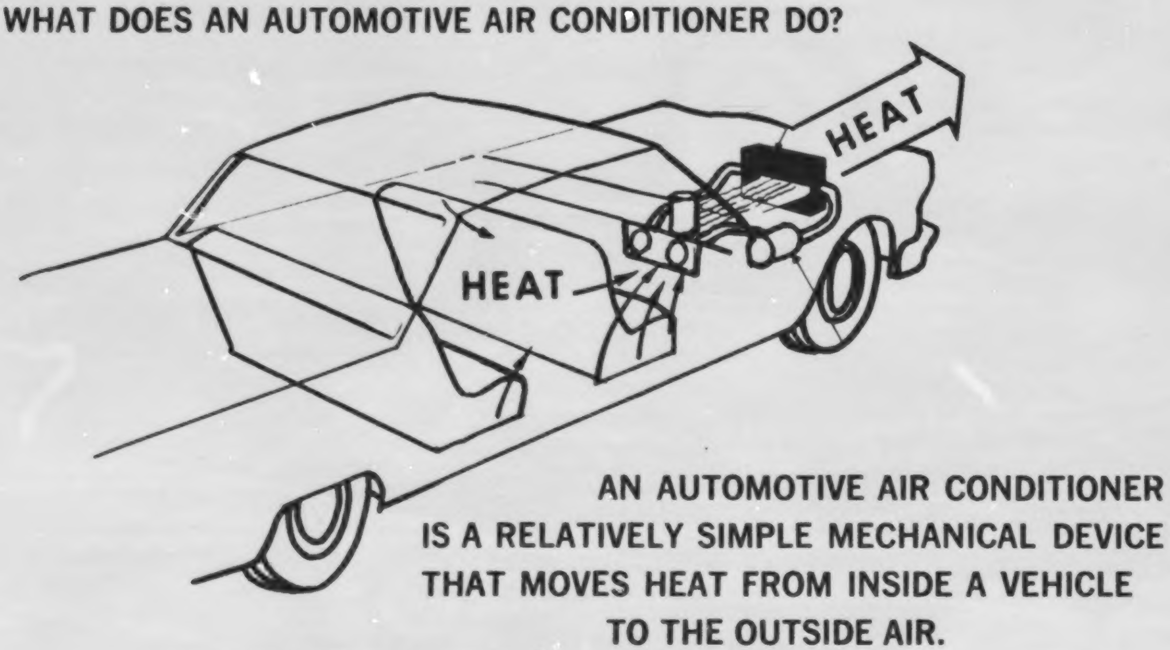

WHAT DOES AN AUTOMOTIVE AIR CONDITIONER DO?
HEAT
HEAT
AN AUTOMOTIVE AIR CONDITIONER IS A RELATIVELY SIMPLE MECHANICAL DEVICE THAT MOVES HEAT FROM INSIDE A VEHICLE TO THE OUTSIDE AIR.

Fig. 25-1. Function of an automotive air-conditioner. (Courtesy Atlas Supply Co.)

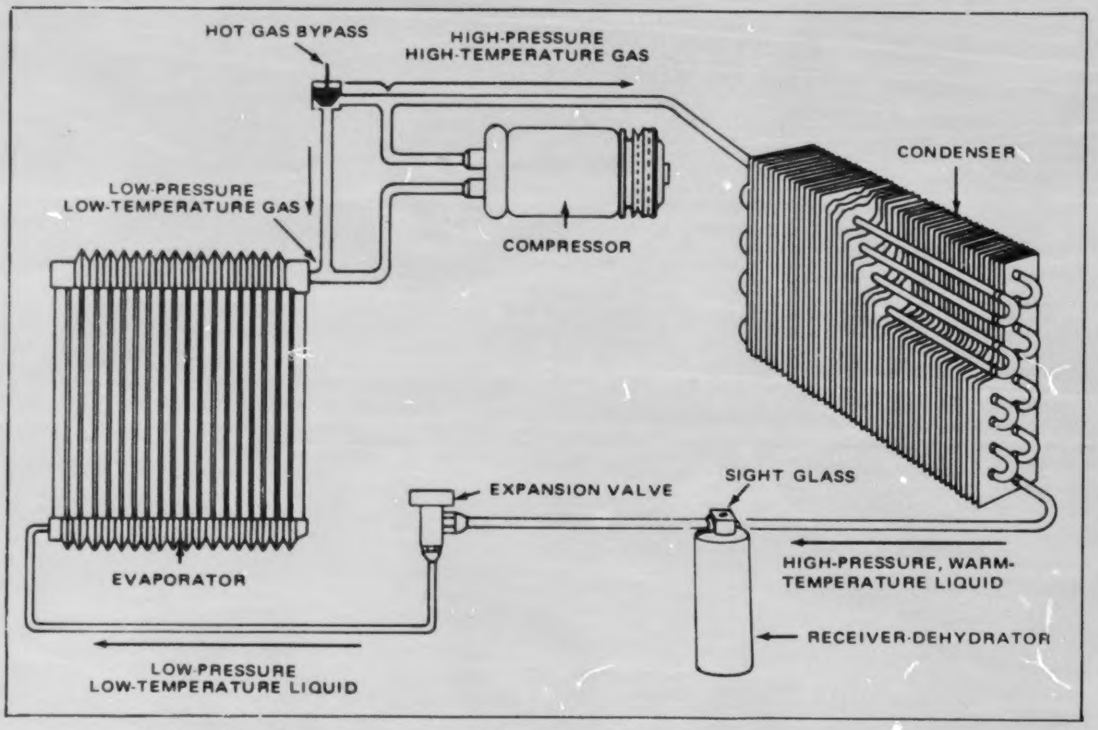

HOT GAS BYPASS
HIGH-PRESSURE HIGH-TEMPERATURE GAS
CONDENSER
LOW-PRESSURE LOW-TEMPERATURE GAS
COMPRESSOR
EXPANSION VALVE
SIGHT GLASS
EVAPORATOR
HIGH-PRESSURE, WARM-TEMPERATURE LIQUID
RECEIVER-DEHYDRATOR
LOW-PRESSURE LOW-TEMPERATURE LIQUID

Fig. 25-2. Component parts of the automotive air-conditioning system

drive pulley on the front of the engine. An *expansion valve* automatically raises and lowers the pressure. An *evaporator coil* inside the vehicle delivers the cooled air. A *fan* distributes the air and circulates it inside the vehicle passenger compartment. The refrigerant is Refrigerant-12 or R-12, a hydrocarbon compound with a low boiling point and a lubricating oil. There are high- and low-pressure lines that connect these component parts with one another.

Evaporator Controls

In a basic refrigeration system, an electric motor turns at a constant speed to drive the compressor. In such a system, the controls are minimal because of the even speed of raising and lowering pressure on the refrigerant. However, in an automobile, the engine seldom runs at a constant speed except on the highway. Since the compressor is driven directly by the engine, the speed varies constantly. To compensate, additional controls are needed to regulate the pressure to the evaporator coils.

The temperature of the evaporator should be as cold as possible, but not freezing or below freezing temperature. If the temperature is too high, no cool air will be delivered. Refrigerant R-12 has a one-to-one ratio between pressure and temperature. That is, for every pound of pressure increase or decrease, there is a one-degree increase or decrease in temperature.

Two controls regulate pressure and temperature changes. The cycling clutch is located on the compressor and is controlled by a *thermostat*. The control simply turns the compressor on and off as the temperature raises or drops. In nearly all compressors, an electromagnet engages or disengages the clutch plate to drive the compressor.

The other control is an *evaporator pressure valve*. Located between the compressor and evaporator, it regulates the amount of pressure on the refrigerant, thus controlling the temperature in the evaporator. Different car manufacturers use different types of valves, but all perform the same function.

Inspecting the System

In routine inspection and maintenance of the automobile, the air-conditioning system requires periodic inspection and service. This assignment will not tell you how to repair any air-conditioning parts. This is the job of an air-conditioning mechanic. If additional information is desired on how to troubleshoot and repair automotive air-conditioning systems, you may order the following publication, *Automotive Air-Conditioning Mechanic*, Student's Manual, from the Center for Occupational Curriculum Development, The University of Texas at Austin.

There are, however, some routine inspection and maintenance services you can perform. These include a visual check of component parts, testing the refrigerant level, and testing for pressure.

When you are looking under the hood, you should make a visual inspection of the air-conditioning system by checking the following:

1. Check the drive belt to the com-

pressor, making sure it has the proper tension, is not frayed, split, or cracked, and has no other signs of wear.

2. Check that the compressor and other components are tightly mounted with no missing bolts or other mounting hardware.
3. See that all electrical wiring is tightly connected, especially that to the magnetic clutch in the compressor.
4. Check that all hoses and connecting hardware are tight, with no signs of leaks. Since R-12 has a lubricating oil, any leakage will produce an oily looking spot on the pressure hoses or around the connections. Hoses must be free of splits, cracks, and other signs of wear and deterioration. If hoses are mounted close to other parts, check to make sure there is no sign of rubbing or damage from heat.
5. Check that the condenser coils mounted in front of the radiator are secure and tight, with no signs of leakage, bent cooling fins, or obstructions that spoil the flow of air.

Condensation on the pressure lines means only that the refrigerant is being circulated and that some cooling is taking place. It does not indicate a leak or malfunction. You should wipe the moisture off the lines completely to inspect them for possible refrigerant leakage or other minor damage. Bends and contours must be smooth without any kinks or sharp-angled bends.

When the engine is started and allowed to run for a few minutes at fast idle, you can observe these conditions:

1. Controls must be functioning, especially the clutch in the compressor. The compressor should be in the "on" position.
2. The high-side lines should be warm and the low-side lines should be cold, forming a light frost or condensation.
3. Check the sight glass in the receiver-dryer tank. Small bubbles appearing in the glass indicate air leakage into the system. Oily streaks indicate low refrigerant, or an almost empty system.
4. Look for signs of refrigerant leakage along the sides of pressure hoses and at the connections.

Testing for Leaks

The major malfunction of automotive air-conditioning is a leakage of the refrigerant. It can leak very slowly and not show up for an entire season. When the cooling power begins to fade away and the fan is distributing only slightly cooled air, then you can be almost assured that the refrigerant has leaked out.

Test procedures are fairly simple, but finding the exact point of leakage is often difficult. Since R-12 is heavier than air, the leakage point will likely be toward the bottom side of hoses and connections. Be sure to look at the underside of all high- and low-pressure hoses. The seals on the compressor are another possible trouble spot, as well as the head gaskets.

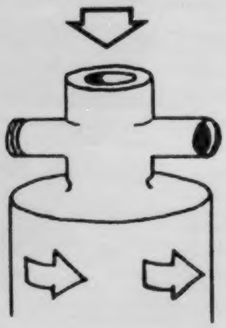
To test for leaks, you need a fully charged system. You must use cans of R-12 refrigerant and special connecting hoses and gauges for this operation, which is described later. There are several methods of testing for leaks.

1. The *electronic leak tester* is most commonly used. The device is very sensitive and uses either a light or audible buzzer to indicate a leak. The device is passed along all hose lines, at connections, and all around the compressor until the source of the leak is found.

2. *Dye* can be put into the system along with the refrigerant. Dye mixes with the oil and R-12 without harm and can be left in the system after leak testing.

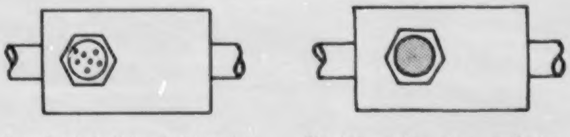
3. An older method is the *propane torch with a halide leak detector.* A rubber hose picks up any small leakage and turns the flame on the torch a bright purple color. A halide detector must be used in a well-ventilated area and with caution. R-12 produces deadly phosgene gas when burned.

SIGHT GLASS



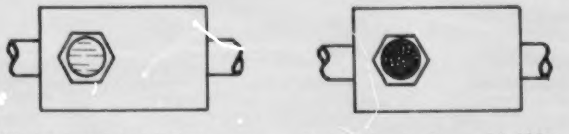
NOTE: If a cap is installed on the sight glass recess, the cap must be removed to inspect refrigerant flow. Always replace cap after checking refrigerant to keep the sight glass clean.
A clear sight glass (solid stream of refrigerant) indicates system has correct charge of refrigerant, or an overcharge (overcharge will be indicated by gauge readings higher than normal).

SIGHT GLASS INDICATIONS



Occasional bubbles indicate system is slightly low on R-12 or that the Receiver-Drier is saturated and releasing some moisture.

Clouded sight glass indicates Receiver-Drier desiccant is breaking down and circulating through the system.



Oil streaks on glass indicate complete absence of refrigerant.

Foam or heavy stream of bubbles shows refrigerant is very low.

Fig. 25-3. Check the sight glass. (Courtesy Atlas Supply Co.)

Pressure Testing the System

To test the pressure in the system, you must have a manifold pressure gauge set and service valves, plus a thermometer. Connect the gauges to the service valves on the system. Then start the engine with all air-conditioning controls in the "on" position. Let the engine run at fast idle, and turn the thermostat to its lowest setting and the fan to its highest setting to get the maximum cooling effort.

After operating the system at maximum for five minutes, turn the fan to its lowest setting, then check the high- and low-side gauges. Each automobile manufacturer has different pressures and readings on their respective systems. You must use the recommended specifications for each make of air-conditioning system. Low-side pressures are checked with the thermostat switch and clutch switch on so that the system is charging. Recommended pressures for low side will vary, so check the service manual. High-side pressures are about the same on each system, regardless of make. These will range from 175 to 190 pounds per square inch (psi). Check the temperature in front of the condenser coils. Most normal operating temperatures will be around 90°F. The higher the temperature, the higher the psi reading on the gauge.

The following conditions are abnormal and need service and attention:

1. Both the low-side and high-side gauges give a lower than normal reading. The condition indicates a low refrigerant level, in need of recharging. All leaks must be located and corrected before recharging.
2. If the above condition is an extremely low reading, it means a completely discharged system. It must be evacuated with a vacuum pump before recharging.
3. If the low side gauge is 0 and the high side is below 175 psi, check the expansion valve. If the inlet side is cool or frosted, it means the valve is stuck in the closed position. Also, it may mean the sensing bulb is clogged or not operating. Clean the valve and screen. If it still does not operate properly, it must be replaced.
4. Low-side and high-side pressures are low, and discharge air is only slightly cool. The lines show some frost or sweating, and the receiver-dryer tank is frosted or sweating. The condition is a clogged tank that needs replacing.
5. The low side is low, and the high side is normal. Check the evaporator coils to see if they are freezing over. The condition usually indicates a defective ETR valve that needs replacing.
6. Same condition as no. 5, but the compressor is cutting in and out rapidly. The condition indicates a faulty thermostat switch.
7. Low-side reading is higher than normal; high-side reading is also high. Sight glass has bubbles, and evaporator is warm. Lines are hot. This condition indicates overcharge. System may have to be discharged and recharged.
8. Same condition as no. 7, but discharge air is slightly cool. Bubbles in the sight glass indicate air in system. It must be evacuated and recharged, after replacing a defective receiver-dryer tank.
9. Low side is high, and high side is low. Sight glass is clear; discharge air is only warm or slightly cool. This condition suggests a faulty compressor. It must be serviced and repaired or replaced.
10. Both high and low side are normal, but there is poor cooling. This condition indicates there is probably air in the system, and it needs a good testing for leaks. Check the receiver-dryer, and replace if necessary. Also, check the oil level in the compressor. A similar condition may also indicate moisture in the system that freezes and clogs the lines. Again, the receiver-dryer tank is faulty and needs replacing.

Servicing the Components

The conditions just described are common problems. In order to correct them, some standard service procedures can be followed. These basic procedures include charging and discharging the system, checking the oil level in the compressor, and evacuating the system.

System Discharge or Purge

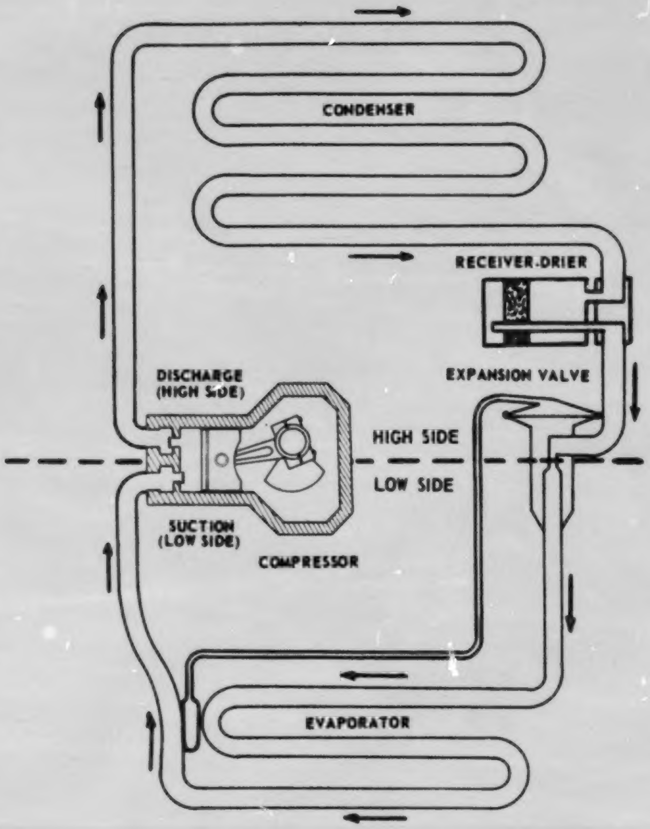
Refrigerant in the air-conditioning system is under pressure. In order to service the system, the refrigerant must be discharged. Shut off the engine and the air-conditioning controls. Connect the manifold gauges and lines to the service valves. The service valves differ on each make, so be sure to follow the steps in the service manual. Place the free end of the center hose on a clean, dry cloth. Slowly open the high-side valve, and let the refrigerant escape. If oil appears on the cloth, it is escaping too rapidly. Slow the rate by closing the valve slightly. When the pressure on the high side drops to 50 psi, open the low-side valve until both gauges register 0. The system is completely discharged, or purged of refrigerant.

Compressor Oil Check

Either the system must be discharged or the compressor has to be isolated from the system before an oil check can be made. In the older General Motors four- and six-cylinder compressors, the unit must be disconnected, and the oil drained and measured. It is not recommended for anyone other than an experienced air-conditioning mechanic. On inline and V-type compressors, there is a plug that can be removed and the oil level checked. See the service manual for the exact procedure and amounts.

System Evacuation

The lines and system of the air-conditioning unit must be evacuated after complete discharge. Both air and moisture enter the system after the refrigerant is removed. Removing them is called "pumping down" or "vacuuming" the system. It requires a vacuum pump. Never use the compressor to evacuate the system. The refrigerant oil is necessary to lubricate the compressor's moving parts. Always follow the vacuum pump manufacturer's step-by-step instructions. Once the system is completely



HIGH SIDE CONTAINS:

1. Discharge side of Compressor and its High Side Service Fitting.
2. Condenser.
3. Receiver-Drier.
4. Inlet half of Expansion Valve.
5. Connecting hoses to all parts described above.

LOW SIDE CONTAINS:

1. Suction side of Compressor and its Low Side Service Fitting.
2. Evaporator.
3. Outlet half of Expansion Valve.
4. Connecting hoses to all parts described above.

Fig. 25-4. High-side and low-side components. (Courtesy Atlas Supply Co.)

pumped down, you can observe the gauges to see if it holds a vacuum. If the gauges rise, it means there is a leak in the system. If the system holds a vacuum, then continue pumping for at least 30 minutes to make sure all of the moisture is completely evaporated.

System Charging

Be sure to check the compressor decal plate for the correct R-12 capacity. Connect the center hose of the manifold gauge set to the safety valve on the can or R-12 refrigerant. Open the can valve slightly to purge the center hose of air. After hose purge, open the can valve and the low-side manifold gauge to let the refrigerant enter the system. Hold the can upright, and sway it gently from side to side. Do not turn the can upside down or lay it on its side. When the first can is empty, close the valve, and carefully remove the empty can. Replace and repeat the process. Continue until the full capacity has been released into the system. Do not overcharge. If the capacity is now known, look in the sight glass. When the bubbles completely disappear, add an additional ¼ to ½ pound of refrigerant. Close the low-side valve.

After complete charging, check the entire system. Let the air-conditioner run at fall capacity for a few minutes, and use a thermometer to check the cool air flow. There should be no streaks, foam, or bubbles in the sight glass of the receiver-dryer tank.

Questions

1. Briefly explain how an automotive air-conditioning system works.
2. Identify the component parts of an automotive air-conditioning system.
3. Name the steps in making a visual inspection of the air-conditioning system.
4. What are some other inspection checks that can be made when the engine is started with the air-conditioner in the "on" position?
5. Name three methods of testing for leaks.

Projects

1. If air-conditioning service is performed at your training station, describe the tools and equipment used, including the leak detector method.
2. Assuming that air-conditioning service is performed at your training station, describe the three most common air-conditioning service problems and how they can be detected with the equipment. Also tell how these three problems are corrected.
3. Describe the method of charging an automotive air-conditioning system at your training station. Give a step-by-step description of this procedure.

26

Brake System Service

Objectives: After completing this assignment, you will be able to—

1. describe the general conditions of brakes looked for in a road test;
2. name six other items that should be checked in a brake inspection;
3. describe the more common conditions that indicate brake drum wear on drum brakes; and
4. tell what conditions should be inspected on drum brakes and on disc brakes.

One of the greatest services you can offer a motorist is to make a thorough inspection and test of the brakes and brake system. Many motorists seldom think about the brakes until they fail. Good, effective brakes are necessary to everyone's safety. A good inspection spots potential brake trouble before an emergency happens. The necessary service, repairs, or adjustments can be made well in advance of need.

Road Test and Safety Inspection

Before you inspect the component parts of the brake system, you should first give the vehicle a road test to determine its general braking condition. In a road test, the vehicle is driven at a speed of 20 mph, and it must be able to stop completely within 25 feet. The vehicle must not sway out of the 12-foot lane when the brakes are applied. If it pulls sharply to one side when the brakes are pressed, it means that the brakes need adjustment or possibly a complete overhaul. Only a more thorough inspection will determine the need of additional adjustments, services, or repairs.

Some kinds of shops and service centers have a brake *dynamometer* (pronounced dine-uh-MOM-uh-ter). This equipment measures the actual braking forces on both the front and rear wheels. For total braking effort, the machine should register that the brakes can hold at least 53 percent of the total weight of the vehicle. For example, if a vehicle has a gross weight of 3,900 pounds, the braking force should be at least 2,067 pounds—53 percent of the total. In addition, the braking force on one wheel should be within 20 percent of the braking force on the opposite wheel. If it exceeds 20 percent, then adjustments are needed.

Additional tests should show that the brake lights are working and that they go off when the brake pedal is released. Check the pedal and linkage. Press and release the brake pedal several times. Move the linkage from side to side. Check for binding, loose or missing hardware, and unusual noises. Check the pedal reserve. A brake pedal swings in an arc. Only 80 percent of that swing should be necessary to fully apply the brakes. At least 20 percent of the swing should be pedal reserve distance.

Check for hydraulic leakage. Press hard on the brake pedal, and hold it for at least 10 seconds. If the pedal begins to sink under steady pressure, then there is leakage somewhere in the hydraulic lines. If the car is equipped with a vacuum reserve booster on the brake system, you may check it as follows. (1) Run the engine at fast idle for about 1 minute, and then turn it off. Wait 90 seconds, and apply the brakes several times. The pedal should get firmer with each succeeding push on the brake pedal. (2) Hold the pedal down firmly, and start the engine. There should be a slight drop in the pedal when the engine starts.

Check the master cylinder, usually located on the firewall under the hood. Look for signs of external leakage, particularly around the gasket seal. Remove any surface dirt, and remove the lid. The fluid level should be near the top—within at least ¼ inch. If there is a diaphragm (pronounced die-uh-fram) inside the cylinder, it should be intact—not torn or in a badly deteriorated condition.

Check all connections, hoses, lines, and fittings. Oily leaks are fairly easy to spot. Flex hoses must not touch any part of the linkage or chassis or other parts when the wheels are moved from one side to the other.

Check the parking brake by inspecting the linkage and cables for possible damage, fraying, binding, or loose connections. Set the parking brake, and try to move the vehicle. On

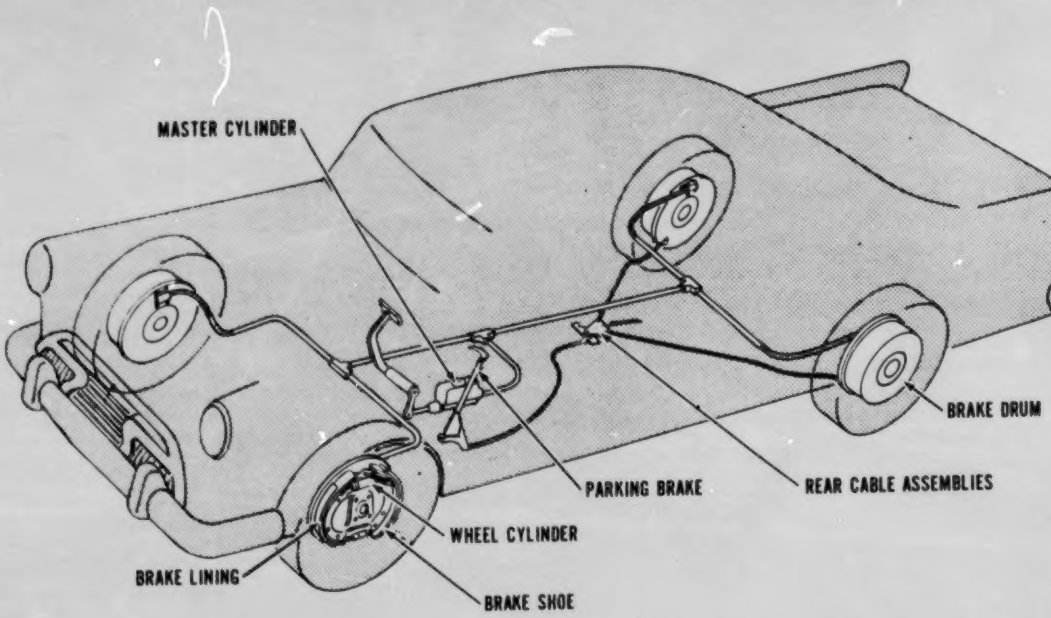


Fig. 26-1. The brake system and its components

pre-1976 models, the brake should hold firmly with only two-thirds pedal travel. On many 1976 and later models there is a ratchet-type parking brake lever. It will hold more securely, but the lever must be pumped several times to get the maximum holding power.

Component Parts Inspection

After the initial inspection outlined above, the vehicle must be put on a hoist to remove the four wheels for brake parts inspection and service.

Drum Brakes

On drum brakes, the first inspection is of the **brake drum** itself. Drums do wear during normal use, and they have a maximum amount of wear that can be tolerated. The maximum diameter of the drum is imprinted on the drum's outer surface by the manufacturer. If refinishing the drum will exceed this maximum, then the drum must be replaced.

These common conditions indicate drum wear: (1) *Scoring* is where the brake linings have worn through and allowed metal-to-metal contact. (2) *Bellmouth* is where the drum wears unevenly on one side, caused by misaligned brake shoes. (3) *Concave and convex wear* is produced by uneven brake shoe pressures. (4) *Heat cracks* are caused by excessive heat buildup from applying brakes too long for extended periods of time. (5) *Out-of-round drums* let the brake lining slip and not hold securely. When brake drums are resurfaced to correct the above conditions, the drum on the wheel opposite must be within 0.020 inch. Otherwise, both drums must be ground or refinished to the same size.

Inspect the **brake shoes and linings.** If the lining is less than 1/32 inch above the rivet head on older types, or less than 1/32 inch at the thinnest spot on the lining, then the linings must be replaced. Most manufacturers recommend replacement when it falls below 1/16 inch. In addition, inspect the linings for these conditions:

- Cracks or breaks
- Loose attachments or missing hardware
- Deposits of oil, grease, and brake fluid
- Worn spots where metal backing plate is showing through

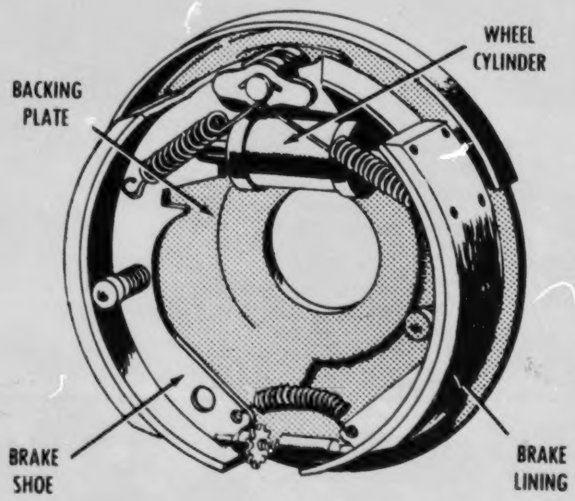


Fig. 26-2. Drum brakes and their parts.

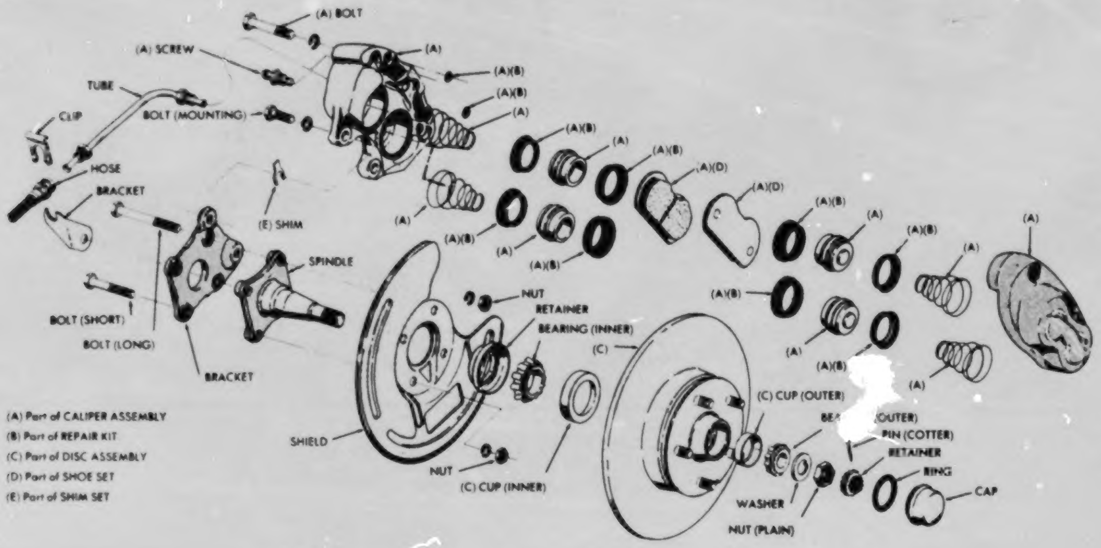


Fig. 26-3. Components of the disc brake assembly

- Bent or warped shoes
- Broken welds
- Worn spots or holes where springs, anchors, and pushrods are attached

Disc Brakes

After removing the wheels, inspect the rotors, calipers, pads, and all other hardware on the brake assembly. The rotor has the same function as the drum on the drum-type brake. It will have similar types of wear patterns, such as scoring, bellmouth, heat cracks, and out-of-line. Scoring happens when the pads wear through and let metal contact metal. A micrometer should be used to measure the rotor thickness. Measure it in several different places around the circumference. The two sides of the rotor must be parallel all the way around, and must not be warped. A runout dial should be used to measure side wobble or warp in the rotor. For very accurate measurements, the rotor should be completely removed and placed on a lathe.

Rotors can be refinished just like brake drums, but the limits are more critical and manufacturer's specifications must be followed. Grinding or resurfacing a rotor beyond its limits destroys the heat-dissipating ability. With heat buildup, the brake's efficiency is greatly reduced.

Inspect the calipers and pads. The lining on the pad should be no less than 1/32 inch above the rivet head or on the thinnest part of the bonded lining. Most manufacturers recommend replacement when the pad lining reaches 1/16 inch. On most types of disc brakes, the calipers have inspection holes so you can easily see the pads and linings. If riveted pads are used, the entire assembly must be removed for inspection. Look for grease, oil, and hydraulic fluid leakage and deposits on the linings and pads. Calipers have to be securely attached, so look at the mounting hardware. Look for missing guide pins, clips, keys, and other security devices that hold the pad in place. None should be damaged.

Inspect the grease seals in the front hub assemblies. If the front disc brake assemblies must be removed for repair, adjustment, or overhaul, then the front wheel bearings should also be removed, inspected, and repacked.

Brake Adjustment

On most American-made cars, the drum-type brakes are self-adjusting. A self-adjusting level keeps the brake shoes in constant alignment and adjustment each time the vehicle is put into reverse gear and the brakes are used. That is, each time a vehicle is backed up, the self-adjusting lever makes a minor movement to readjust the brake shoes. Therefore, unless the self-adjusting lever is broken or not working properly, most drum brakes seldom require this service.

If a car pulls of sways to one side when the brakes are pressed, it usually means some other type of brake malfunction. If, however, visual inspection shows that all the components and assemblies are in good working order, it may be nothing more than an adjustment problem. There is a hole in each backing plate with a removable cover. After removing the cover, you can reach through with a special adjusting tool. There is a *star wheel* that the tool rotates to make the adjustment on the brake shoe. Turn the star wheel until you feel a drag while rotating the wheel. Then back off the star wheel about fifteen turns, or until you do not notice any drag and the wheel is rotating freely. You must use a screwdriver to hold off the self-adjusting lever while moving the star wheel.

Brake Repair and Overhaul

Many shops and stations offer full brake overhaul and repair service. It is recommended that these jobs be undertaken only by a trained mechanic who knows the repair techniques and use of equipment.

Questions

1. Describe the road test for brakes and what to look for.
2. Name six other items that should be checked in the overall brake system test.
3. Name the more common conditions that indicate brake drum wear on drum brakes.
4. What conditions are looked for when inspecting the brake shoes and linings of drum brakes?
5. What conditions should be inspected on disc brakes?

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27

Cooling System Service

Objectives: After completing this assignment, you will be able to—

1. explain the importance of regular inspection and checking of the cooling system;
2. tell how to properly inspect a cooling system;
3. explain the purpose of the thermostat and the radiator cap; and
4. tell when to use each of the three methods of flushing the cooling system on an automobile engine.

Like all other systems of the automobile, the cooling system is vital to the engine's operation. It requires regular inspection and service. The cooling system should be inspected and serviced each time an automobile stops for refueling. This is particularly important during hot weather and after long periods of highway driving.

Today's motor vehicle engines operate at a higher temperature than ever before. The cooling system is pressurized so that the coolant will not boil away, yet will carry away the engine's heat. A combination of pressure and antifreeze mixture permits this higher temperature. High heat is necessary to burn off the harmful gases, deposits, and pollutants inside the engine's combustion chamber.

During hot weather or after the engine has been operating at maximum temperature and the engine is shut off, the pressure inside the cooling system builds to its highest level. This is the best time to inspect the cooling system and check for leaks in hoses and at the seals. Any leak, no matter how small, will show up during this period.

Inspecting the System

A routine inspection of the cooling system begins with the radiator and connecting hoses. On most newer models, the radiator top tank has a cap that should be left intact. Rather than removing the cap that lets off the pressure and steam, you inspect the overflow-and-fill reservoir to the side of the radiator. If the tank is low or dry, then add the coolant there rather than in the radiator itself.

On older models without a reservoir tank you must remove the radiator cap. When the radiator is hot, use a rag or insulating material to prevent burns and scalds. Turn the cap only one-half turn to release the pressure, and wait for steam or boilover to stop. Once the pressure is released, then remove the cap. The tank should have coolant showing above the radiator tubes. If the coolant is below this level, then add more, but do not overfill or fill completely to the top. Overfilling leaves no room for expansion when the operating temperature rises.

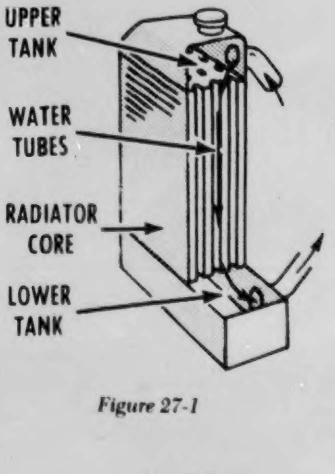


Figure 27-1

Look for signs of excessive corrosion and sludge when inspecting the radiator tank. Heavy buildup of rust and sludge means that the cooling system is partially stopped up and needs cleaning. Show the owner what you have found, and suggest a complete cleaning or at least the addition of a can of rust inhibitor. A heavily sludged system will eventually close off the radiator tubes, ruin the water pump, and coat the thermostat so that it does not open and close properly. An engine will not operate efficiently unless the cooling system is doing its work.

Most owner's manuals recommend that the coolant be at least a half-and-half mixture of antifreeze and water for year-round operation. Antifreeze should be of the antirusting type, usually an ethylene glycol chemical compound.

After inspecting the radiator top tank, fill reservoir, and pressure cap, look at the top hose that comes from the engine block to the radiator fill tank. Squeeze the hose with a firm grip. It should be soft and pliable. Look for signs of aging, cracking, fraying, checking, or exposed cords. Check the seals for any sign of leakage around them. If the hose shows signs of age or is hard when squeezed, then suggest a replacement to avoid future trouble.

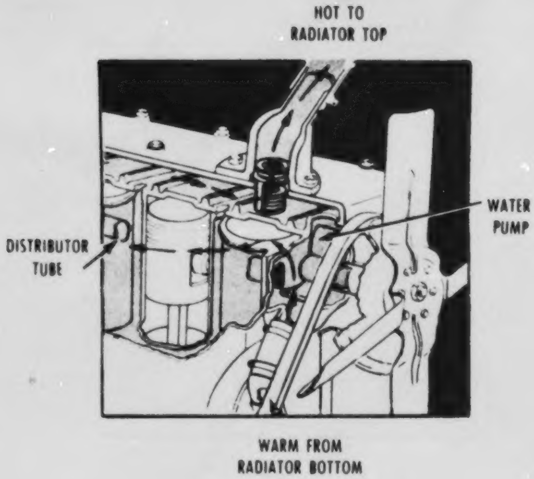


Figure 27-2

Look at the front of the radiator to see if anything is covering the free flow of air over the fins. The fins should be straight and not damaged. Look for telltale signs of water leakage immediately under the radiator. Inspect the bottom tank and hose.

Inspect the front of the engine block around the water pump housing to make sure there are no leaks there. Inspect the drive belts to make sure they are properly tensioned and not frayed or damaged. A drive belt should not have more than ½ inch of give when firmly pressed with the thumb. Finally, check the thermostat housing to see that there are no leaks at the gasket seal. Look underneath the engine block itself for telltale signs of water leakage that may be coming from the freeze plugs on the lower block side.

Servicing the System

Replacement of drive belts and hoses is discussed in Assignment 18. Normal servicing of the cooling system includes the checking and replacement of the thermostat, and cleaning and flushing the system.

Servicing the Thermostat

To do an effective job of cooling, the system must have controlled circulation. The control device is the thermostat located on top of the front engine block and at the lower end of the top radiator hose. On most Chrysler products, there is a smaller bypass hose from the top of the block that goes around the thermostat.

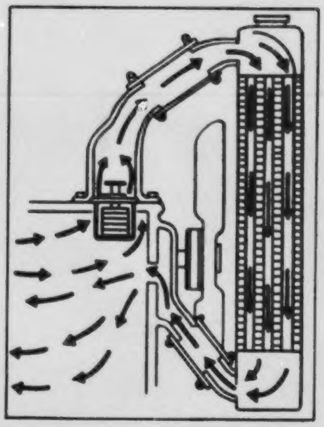
The thermostat itself is a valve that opens and closes by spring pressure. When the coolant mixture is cool, the thermostat is closed, and only a small amount is permitted to bypass the thermostat and circulate. When the engine reaches maximum operating temperature, the thermostat opens and allows the coolant to circulate at full flow. If the engine is overheating, particularly when idling, or if the warning light comes on erratically, then check the thermostat.

Look in the top of the radiator tank when the engine is hot to see if the water is circulating fully. If the flow is small, then the thermostat is stuck closed. If there is a full flow of coolant into the top tank when the engine is cold, then the thermostat is stuck in the open position.

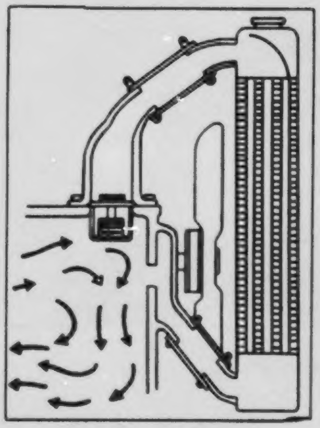
Remove the thermostat housing and top radiator hose. Remove the thermostat and inspect it. If it appears to be clean and in good condition, then it should be checked in a regular thermostat cup. This is a can with a thermometer that can be filled with water and heated electrically. When the water reaches 212°F, or boiling, the thermostat should open fully. If it does not, then replace the thermostat with a new one of the same type and heat range. Remember, in a pressurized cooling system, the boiling range is raised by 3° for every inch of pressure. So, in a 15-psi system, the boiling point of the coolant is 45° higher than the 212°F under normal conditions. This means that the coolant can run as high as 255°F and still not boil. Make sure you check the specifications and get the right thermostat for the engine, make, and model of the car as recommended by the manufacturer.

When reinstalling the thermostat, make sure it is properly seated with the domed end up or pointing toward the top radiator tank. The spring or loaded end should be toward the engine block. Most will show by arrows the direction of coolant flow.

Use the proper gasket and gasket cement on the thermostat housing and block. Replace the thermostat housing, and reattach the top radiator hose, making sure the seals are tightened. Restart the engine, let it get to maximum operating temperature, and



Thermostat Open



Thermostat Closed

Figure 27-3

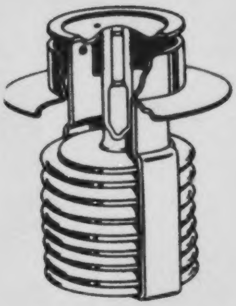


Fig. 27-4. Thermostat

then check for leaks. Look inside the top tank to make sure the water is flowing properly.

Radiator Caps

Sometimes a poorly operating cooling system is caused by a faulty radiator cap. The pressure is created by a spring-loaded cap that is set to vary from 12 psi to 17 psi on most American-made cars. Pressure will vary on foreign makes. You should check the owner's manual or manufacturer's guide and specification book.

Look at the inside of the radiator cap to see if it is clean or if it is fouled with rust and sludge. A badly rusted or sludged radiator cap should be replaced with a new one. Make sure it is the correct size and pressure.

Cleaning and Flushing the System

A cooling system should be completely drained and flushed once each year. Most motorists never think about the necessity and seldom have it done unless the system gets stopped up with rust, corrosion, and sludge. Antifreeze will soon lose its effectiveness, so a system should be flushed at least every 12,000 to 15,000 miles, and new coolant added. There are three ways to flush a system—with plain water, with chemicals, and by back-flushing.

Plain water flushing. For a system that is not rusted or corroded with sludge, a plain water flush will do. This is a fairly simple process that doesn't take long. It begins with a complete draining of the system through the lower radiator drain cock. On newer models that do not have a drain cock, first disconnect the lower radiator hose from the radiator bottom tank. Second, remove the thermostat, and replace the housing. Third, place a water hose in the top of the radiator tank, and begin running a stream of water through. Next, start the engine and let it idle. Put a stream of water into the lower radiator hose so that it is drawn up through the engine block. When the water is running clear all the way through, then shut off the engine and water.

After flushing, reinstall the thermostat, and reclose all drain cocks and openings. Fill the radiator with the proper mixture of coolant, and restart the engine. Keep filling the radiator until the system is at the proper level. Check for leaks, and tighten all hose connections. Make sure the thermostat housing is properly sealed and not leaking.

Chemical flushing. Where a system is badly rusted, corroded, and filled with sludge, a chemical flushing is necessary. First drain the present coolant from the radiator, and remove the thermostat. Replace the thermostat housing. Add the chemical to the top of the radiator tank, following the recommended amounts stated on the label. Refill the system with water, and let the engine idle for at least 30 minutes. To increase the temperature quickly, you can cover half of the radiator with paper or plastic sheeting. Or you can drive the automobile at highway speeds for about 30 minutes to get the same cleansing effect.

Stop the engine, and drain the entire system while the engine is hot, following the same procedure as in the plain water flushing. Make sure you let the water run for at least 10 minutes with the engine at idle. This neutralizes all the acids in the chemical cleaner, If any acid remains, it will kill the effectiveness of the antifreeze in the coolant. Refill the system with the proper coolant mixture, and follow the same procedures as in the plain water flushing.

Reverse- or back-flushing. Under certain conditions, water has a high concentration of minerals, forming scale and rust inside the cooling system. For back-flushing, you need plain water and compressed air.

First, with the radiator cap in place, remove both hoses from the radiator, and attach flushing hoses to both openings. Next, attach the flushing gun to the lower hose, and fill the radiator with water. Let the water and compressed air gun force the water and coolant in reverse order so that the mixture is forced upward through the radiator and out the top opening. Apply air from the gun in short spurts to loosen the rust and mineral scale. Continue this action until the water from the top hose is running clean and clear of rust and scale.

To reverse-flush the engine block, attach the flushing gun to the top opening on the block or through the thermostat housing with thermostat removed. Let the water flow through the engine and out the lower hose. After a thorough cleansing, reattach the hoses, replace the thermostat, and check all clamps for leaks. Refill the system with the proper coolant mixture.

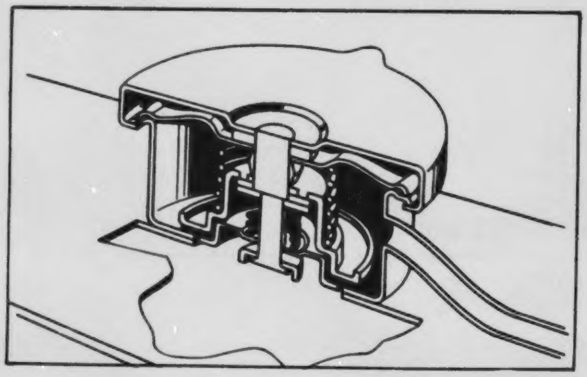


Fig. 27-5. Radiator cap

Core Plugs

If a pressure test indicates a small amount of leakage, but it cannot be found in the hoses, clamps, radiator, radiator cap, or thermostat, then the core plugs in the lower block side are leaking. Look for telltale signs of rust or antifreeze stains. If there are indications of leaking, the plugs should be removed and replaced. To do this, you must first drain the coolant from the system. If the coolant is new or in good condition, it can be saved and reused.

Punch a small hole through the core plug center. Use a slide hammer seal-puller tool. Tap the hammer until the plug comes out. If the seal is too badly rusted and cannot be removed this way, drive it into the water jacket. Crumple the seal with your fingers, and remove it through the opening.

Next, clean the core plug holes, and sand off all rust, scale, and other foreign matter. Install a new core plug of the correct size, hammering it so that the shoulder is gradually forced into the opening. Radial pressure will hold it in place. Refill the cooling system with coolant mixture, start the engine, and let it idle for 30 minutes. Then check the core plugs for leaks.

Questions

1. Why is frequent inspection of the cooling system recommended?
2. What should you look for when inspecting the car's cooling system?
3. What is the purpose of the thermostat, and where is it found?
4. How do you test to see if the thermostat is working properly?
5. What is the purpose of the radiator cap?
6. When do you use plain water flushing, chemical flushing, and reverse- or back-flushing?

Project

Prepare a list of the cooling system services provided by your training station. Which of these are you able to perform (1) with assistance and (2) without assistance? Prepare a list of the cooling system products carried by your training station. Beside each item, make a brief statement about the product and when it is recommended. Do not include drive belts and radiator hoses, thermostats, radiator caps, and other normal replacement items.

Objectives: After completing this assignment, you will be able to—

1. name the tools and equipment needed for lubrication;
2. describe the preparation needed before lubricating the fittings;
3. name the parts that need inspection and lubrication under the chassis, under the hood, and on the body;
4. describe the inspection needed for the power steering system; and
5. list and illustrate the necessary lubrication points on a selected make and model of automobile.

28

Chassis Lubrication Service

The chassis of the automobile requires periodic lubrication to keep it quiet and free from malfunctions. Almost every establishment that has car services has a lubrication bay where these services are performed. To lubricate the chassis requires either a hydraulic hoist or a lubrication pit where the underside of the frame and front end can be easily reached.

The Tools

Lubrication tools and equipment include an air compressor, forced-air hoses to dispense the bulk lubricant, and a variety of special nozzles and applicators to fit the various kinds of fittings. For some special types of applications, a hand-operated gun with a grease cartridge is used. It is especially good where high-pressure guns are not desirable.

Plugs and Fittings

There are only a few fittings and lubrication points on most modern automobiles. These are located on the front-end assembly and steering mechanism. Each make of automobile has either a permanent fitting to receive the lubrication or a plug that must be removed before lubricating. The plastic fittings or plugs must be removed, discarded, and replaced with new ones. High-pressure fittings are permanent and require only cleaning with a rag before putting the nozzle over them. Lubrication greases on suspension joints need replacing because the constant motion, jolts, bumps, and jars force the lubrication out of the joints and because splashing water eventually washes out the lubrication.

Each manufacturer recommends certain intervals between lubrication. There is a lubrication chart that shows each make and model, the lubrication points, and type of lubrication to be

Fig. 28-1. Position chassis and frame on the hoist so that all lubrication fittings can be reached.

Figures 28-1 through 28-6 are provided courtesy of the National Lubricating Grease Institute.

Fig. 28-2. Wipe dirt and old grease from each fitting before using applicator gun

Fig. 28-3. Apply grease until it squeezes from the joint.

Fig. 28-4. Wipe off excess grease with a rag.

Fig. 28-5. Use a hand applicator on joints that will be damaged by high pressure.

used. Always consult the lubrication chart before starting the job. Never go on guesswork. You may overlook a vital part.

Always wipe the dirt and grease off the fittings and plugs before inserting the lubrication nozzle. Apply the grease with a steady pressure and in short spurts until you see the old grease squeezing from the joint. Never pull the gun nozzle directly off the fitting, but swing the gun nozzle to one side and in an arc to remove it. Make sure you replace plugs that have been removed. To prevent accidents, wipe up any lubricant that spills or drops on the floor.

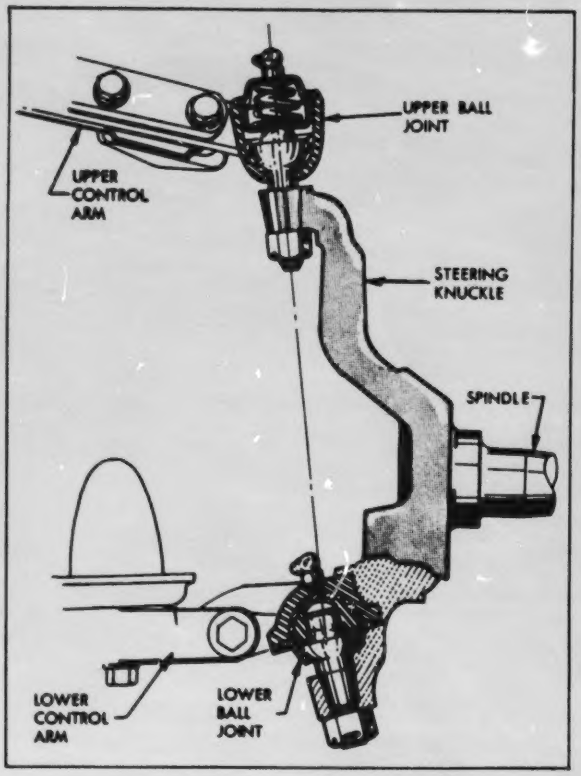


Fig. 28-6. Make sure upper and lower ball joints are properly lubricated.

Lubrication Service Other than Chassis

A complete lubrication job requires checking a number of points and places in addition to the chassis grease fittings. A step-by-step routine includes the following:

1. **Under the chassis** are several other places that need to be checked and given periodic service. The service charts will indicate the time intervals on each make and model of vehicle when lubrication is required. Check the wheel bearings on the front, and repack as required. Inspect the universal joints on the drive shaft. Some have fittings that allow easy lubrication. Others will require more extensive lubrication and inspection. On vehicles with manual transmission, there is a fitting on the clutch cross shaft that requires periodic lubrication. Lubricate the rear spring shackles where leaf springs are installed. If the leaf springs are squeaking, squirt penetrating oil between the spring leaves. Lubricate the parking brake cable. The pulleys and links should have a light coating of lubricant. Check the fluid levels in the manual transmission and in the differential housing. Add fluid as needed, but only after checking the specification manual for the proper level and type of fluid required.

2. Lubrication services **under the hood** include checking the power steering and brake pump. The fill cap usually has a dipstick to indicate the level and when it is low. Be sure to fill with the proper type of fluid. Check the brake system reservoir, and add brake fluid as needed. On older models without electronic ignition, check the lubricant on the cam of the distributor. Do not overlubricate. Wipe off any excess oil or grease, and be sure none gets on the points or electrical connections. Lubricate the manifold heat riser valve. If the valve is excessively rusted and corroded, free it with a solvent oil first, working the valve back and forth until it moves easily. Lubricate the hood hinges and front latch mechanism.

Under-the-hood lubrication also includes checking the water-solvent reservoir on the windshield wiper-washer mechanism. Fill the reservoir as needed with a solvent solution made for that purpose.

3. **Body lubrication** includes oiling the door hinges on all doors, and applying the right kind of lubricant to the door latch and striker plates. In addition, check the trunk spring and lock mechanism. Lubricate as needed, but use lubricants sparingly. Too much is worse than too little. Use a rag to catch the excess so that it will not run down into the trunk area.

Servicing Power Steering

Most American-made vehicles today have power steering, especially those equipped with air-conditioning. The added weight on the front end makes power steering a necessity rather than an option.

The two main types of power steering mechanisms are (1) linkage or booster type and (2) integral. Both use a hydraulic pump to operate. The pump is powered by the engine driven by a belt from the front-end main pulley. Both systems have the same basic parts for operation. These include the pump and fluid reservoir, control valve, power cylinder to move the steering linkage, and the power hoses from the pump to the cylinder.

The *booster* type has four hoses—one high-pressure line, one return line, and two smaller cylinder lines. The

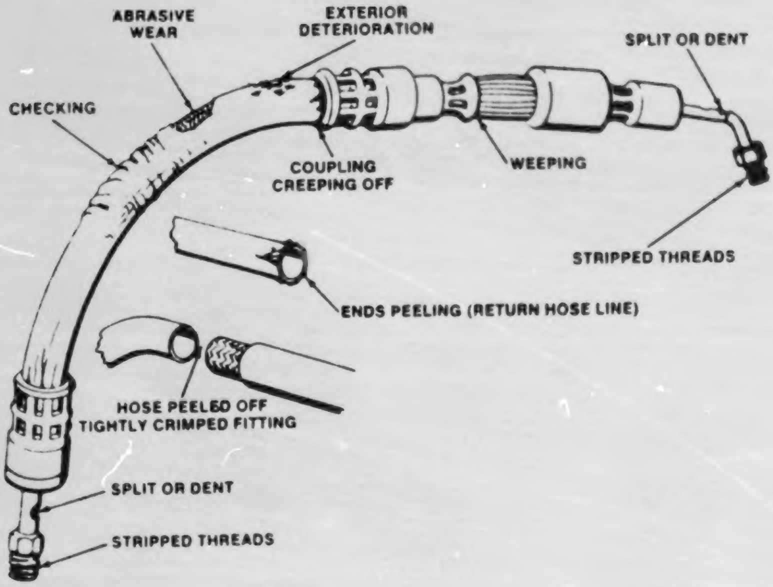


Fig. 28-7. Inspect the overall condition of power steering hoses and connections.

pressure and cylinder lines carry up to 1,100 psi of pressure, while the return line requires only about 40 psi. The *integral* system, which is found on most cars today, has only two pressure lines going from the pump to the cylinder. The high-pressure line carries up to 1,300 psi, while the return line carries only about 50 psi.

Power steering fluid is specially formulated and is almost the same as automatic transmission fluid. In fact, automatic transmission fluid can be used in most power steering pumps, but you should make sure first by checking the service manual. The fluid must contain rust inhibitors and be compatible with rubber and neoprene gaskets and seals. It must not break down under high heat and pressure, and it must remain stable and free-flowing at temperatures below freezing.

One of your regular under-the-hood inspection and service points should be a good look at the power steering components and hoses. The pump itself should be solidly mounted on the brackets with no missing bolts. The drive belt should be inspected for tension and for cracking, checking, and fraying. It should not be too tight, and the pulley on the pump should be turning in line and not with a wobble. The pressure lines are most critical. Check for worn or cracked hose couplings and for fraying or cracking along the line itself. Look for small pinhole leaks where an oily spot will appear. This is the first sign of deterioration, and the hose will soon break or split open under the high pressure. Look for any place where the hoses may be rubbing against the engine block or any other part of the body. The hoses should not be on or near the exhaust manifold.

Check the power cylinder for signs of oil weepage, particularly around the seals and where the pressure hoses attach. Sometimes a squealing or noisy power steering system has air bubbles. To get rid of this noise, you should drain the power steering system and replace the fluid. To drain, disconnect the pressure hose from the control valve or power cylinder, and let the fluid drain into a container. Start the engine and let it idle. Turn the wheels all the way to each extreme position, but do not hold it in the extreme position for more than a few seconds. This will rid the lines of any air bubbles. Stop the engine. Reconnect the hoses, and fill the system with *new* fluid. Throw away the fluid that was drained out.

To replace worn hoses, you must reinstall exactly the same type, kind, and length as removed. Check the service manual. Few dealers stock these hoses except auto parts houses. Make sure the replacement hose is the same length as the one removed. A hose that is too long will vibrate against the other parts and will soon have a worn spot as well as make excessive noise. A hose that is too short will not let the fluid flow correctly and will likely spring a leak at the connecting joint.

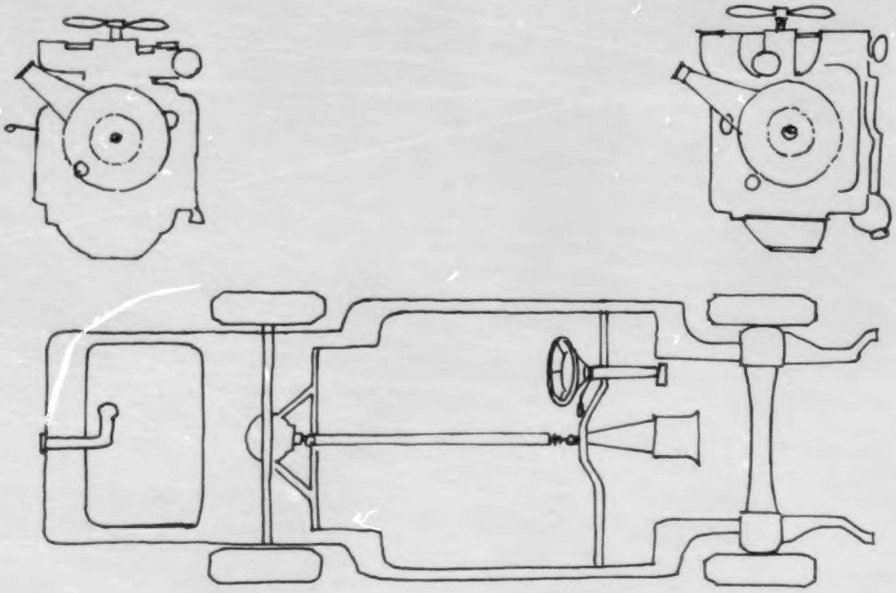
To replace the hose, first drain the system of fluid. Check the threaded ends, and carefully insert them so that the threads are not stripped. Remove any dirt, oil, and grease from around the threaded hole. Hand-start the threaded ends and tighten with a wrench, but use a torque wrench only to manufacturer's specifications. Fill the system with fluid. Start the engine, and check the system for leaks and completely free operation with no binding of the steering linkage.

Questions

1. What are the tools and equipment required for proper chassis lubrication?
2. Why does the front-end assembly need periodic lubrication?
3. What preparation is necessary before lubricating the fittings?
4. Name the parts that need inspection and lubrication service under the chassis.
5. Name the parts that need inspection and lubrication service under the hood.
6. Name the body parts that need inspection and lubrication.
7. What fluid is used in the power steering system?
8. What visual inspection should be made of the power steering system?

Project

If your training station provides lubrication service, make a lubrication chart as follows: Select any make or model automobile you wish. Obtain the lubrication chart for that make and model from your training station. Make a rough sketch of the chassis and component parts (as shown in the illustration below). Prepare a list of lubrication and inspection points for that model and make. Note any special applicators needed for lubrication. Place a star by each part that needs service.



29

Servicing Wheel Bearings and Universal Joints

Objectives: After completing this assignment, you will be able to—

1. tell what causes the lubricant to wear out in wheel bearings;
2. describe the disassembly and removal of front wheel bearings from drum brakes;
3. tell what signs of wear to look for when inspecting wheel bearings; and
4. name and describe the three common types of universal joints.

Servicing Wheel Bearings

The front-end suspension system of an automobile is a marvel of engineering. Because it seldom gives problems, few motorists ever think about it. One small but very important component is the front wheel bearing assembly. It will work well and be troublefree for many miles, but it does require periodic inspection, service, and repacking. Lubrication is vital to its smoothness and troublefree operation. In fact, most bearing assemblies will last as long as the vehicle if serviced at regular prescribed intervals. Most new cars can operate up to 30,000 miles or longer without bearing lubrication. However, all should be inspected every 20,000 miles to see if they are aligned, lubricated, or showing wear.

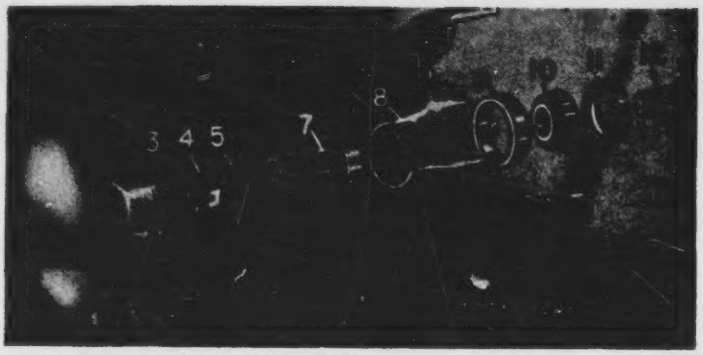
Any time brake service is performed, the front wheel bearings should be removed, cleaned, and repacked. It is a fairly simple operation once the brake drums and brake assembly are removed. If that much labor has been spent on the brakes, then it is foolish *not* to inspect and service the wheel bearings.

Wheel bearings need periodic lubrication because dirt and moisture enter the bearing assemblies even with improved seals. In addition, heat from braking gradually erodes the lubricant so that it becomes increasingly less effective.

Wheel bearings will make noise when they begin to wear out. Usually, the driver will detect a rattling or grating sound toward the front, which is very noticeable when braking or slowing down. It is also noticeable when turning a sharp corner. To make sure it is the wheel bearings, jack up the front end, and spin the front wheels. A clicking or grinding noise is a sure sign of bad bearings that need replacement. Rear wheel bearings seldom give problems, but they occasionally wear out. A whirring noise in the rear end at all speeds is a good indication of bad rear wheel bearings.

Wheel bearings for front ends are almost always the tapered roller type. Only on older models will you still find the ball bearing. You must know the bearing parts and how they are assembled so you will know how to disassemble and reinstall them.

The front wheels have two bearing assemblies. When you remove the outer axle hub and remove the wheel, the inner bearing assembly comes off with the wheel. The outer bearing remains on the axle. The outer bearing race is pressed onto the axle and does



1. Hub Cap
2. Dust Cap
3. Cotter Pin
4. Spindle Nut
5. Washer
6. Cone of Outside Bearing
7. Cup of Outside Bearing
8. Hub
9. Cup of Inside Bearing
10. Cone of Inside Bearing
11. Grease Retainer
12. Spindle

Fig. 29-1. Parts and assembly of the front wheel bearings

Figures 29-1 through 29-8 are provided courtesy of the National Lubricating Grease Institute

Fig. 29-2. Use a bearing washer to clean old grease from bearing assembly.

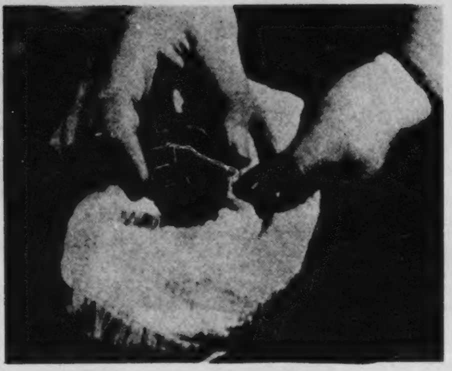


Fig. 29-3. Wipe bearing assembly to remove all solvent and dirt.

not have to be removed for service and repacking. It is a good idea to mark the wheel and bearing assembly so that they can be reinstalled in the same position to retain wheel balance.

On drum brakes, remove the wheel cover, spindle dust cap, cotter pin, nut lock, adjusting retaining nut, and tongued washer. Put all of these in a container of grease solvent. Throw away the cotter pin because you will use a new one when reassembling. Rock the wheel slightly to loosen the outer bearing assembly. Remove the assembly, and put it into the solvent container. Leave the bearing race in place unless you must put new bearings on the axle.

Once the wheel is removed, use a wooden dowel rod and mallet to drive

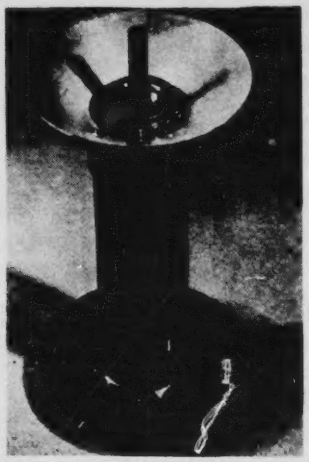


Fig. 29-4. Use a bearing packer to hold assembly.

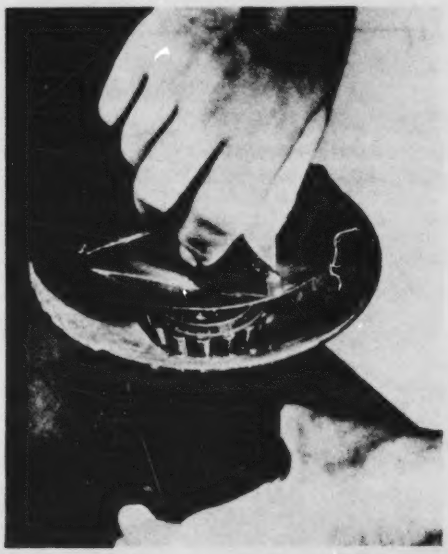


Fig. 29-5. Force grease into all spaces of the assembly.

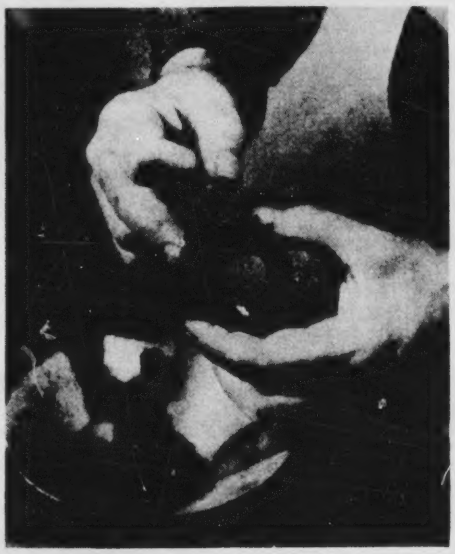


Fig. 29-6. Finish assembly with a coating of grease on outside surfaces.

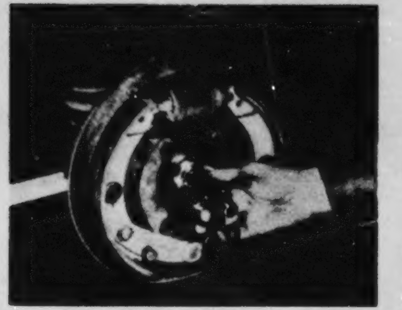


Fig. 29-7. Put grease on spindle hubs before replacing bearing assemblies.

out the inner bearing assembly. Throw away the grease seal. Place the inner bearing assembly in the solvent.

Next, wash all grease from inside the hub and the axle spindle. Clean and inspect the bearing races. Wash all bearing surfaces with solvent, using a stiff brush and finishing with a soft cloth. Use compressed air to blow the solvent and grease out of the assembly, but try not to let it spin. The bearing surfaces at this point have no lubrication, and spinning will mar the delicate surfaces.

After cleaning and inspecting the bearings, repack them with the proper lubricant. Consult the lubrication guide for specifications on the right grease or lubricant to use. The wrong lubricant will damage the entire assembly. You should never add new grease to old. Always clean and repack with new lubricant. If you repack by hand, make sure that you firmly pack the grease, forcing it in to fill all air spaces. Make sure every metal surface has a coating of grease to prevent rust. Coat the entire axle spindle with grease.

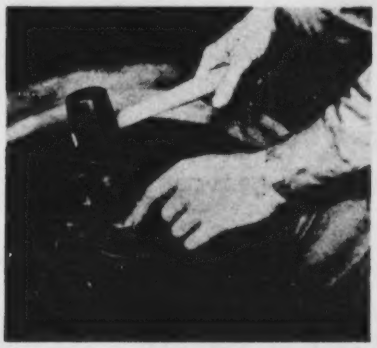


Fig. 29-8. Reseat bearings in wheel, using a rubber mallet to tap them in place.

To reinstall, place the inner bearing assembly into the wheel opening. Tap the bearing into place with a seal driver or block of hardwood. Never hammer directly onto the seal or bearing assembly. Carefully install the wheel or hub onto the spindle, making sure you do not drag it. When the wheel is on as far as it will go, then replace the outer bearing assembly. Next, return the tongued washer and adjusting nut. Check the manufacturer's specification and assembly guide for the amount of play to be left and how to adjust the outer nut before putting the cotter pin in place. Replace the hub, and tighten the lug nuts.

On **disc brakes,** the steps are the same except for wheel removal. The front brake caliper must be removed before the hub and rotor can be removed. Remove the caliper bolts, clips, and pins. The rotor contains the inner bearing assembly. This is treated the same as in drum brake removal and reassembly just described.

Bearing Inspection

After the bearing assembly is removed and the parts cleaned in solvent, inspect them for damage and wear before repacking. First, look at the bearing race left on the spindle. It should have a perfectly smooth surface with no signs of cupping where the rollers have worn into the race. Also, check for cracks and corrosion or pitting. Make sure that no small piece of the race has flaked off.

Check the bearing assembly, especially the rollers. Rotate them slowly, and look for signs of corrosion and end flaking. Even though the roller surfaces may be good, if the ends are chipped or flaked, they must be replaced. All surfaces should be bright. A bluish or brownish coloring means the surfaces have become overheated and will probably fail later on. If you check the entire assembly by rotating to check for tightness, then give the surfaces a light coat of oil first. Never spin the bearings with no lubricant.

Any sign of cracking, chipping, cupping, flaking, corrosion, or overheating indicates that the entire bearing assembly must be replaced. You cannot replace individual parts. Bearings come only in matched sets, so even the race must be removed from the axle spindle. Drive it off with a wooden dowel and mallet. Give the spindle a good cleaning first, then coat with lubricant before replacing the bearing assembly.

Servicing Universal Joints

The drive shaft transmits power from the engine through the transmission to the differential. The motion is rotary so the drive shaft must spin. Since the rear end moves up and down with spring action, the drive shaft must be flexible. To achieve that flexibility, the drive shaft is fitted at either end with a yoke and universal joint—or U-joint as it is often called. Some drive shafts are also fitted with a U-joint in the center.

The universal joint is an engineering marvel. It can move up and down while spinning. There are three basic designs of universal joints.

1. The most common type is **cross and yoke.** The yoke is a U-shaped piece on the end of the shaft that has two holes in the upper end of the U. The crosspiece is an X-shaped piece with four spindles that fit into the holes of the yokes. So that they operate smoothly, each spindle is fitted with a bearing and journal. These must be lubricated just like the wheel bearings.

2. A similar type is called **constant velocity.** It uses two crosspieces and two yokes with a connecting center yoke. This improved design permits the two drive shafts to turn at the same speed while maintaining alignment. It reduces vibration.

3. The **ball-and-trunnion** type uses a short pin on the end of the drive shaft section and it fits inside the U-joint housing. The two pins fit inside grooves and ride inside a bushing with bearings.

Because of the up-and-down motion in the rear end, the drive shaft must be able to move up and down while it rotates. However, another problem is that the rear end moves forward and backward as the car travels over bumps, holes, and uneven road surfaces. To compensate, the drive shaft is splined so the universal joint yokes can move in and out at the same time that it moves up and down.

The universal joint, regardless of type, and the splines must be lubricated periodically. If kept lubricated, universal joints seldom give problems, but occasionally some will have to be replaced. Most universal joints in today's automobiles are permanently lubricated. They need only periodic inspection for wear and replacement. Older models will have universal joints with grease fittings. These should be lubricated each time the vehicle is brought in for lubrication service. For those that do not have fittings, the universal joint must be disassembled, cleaned, and lubricated.

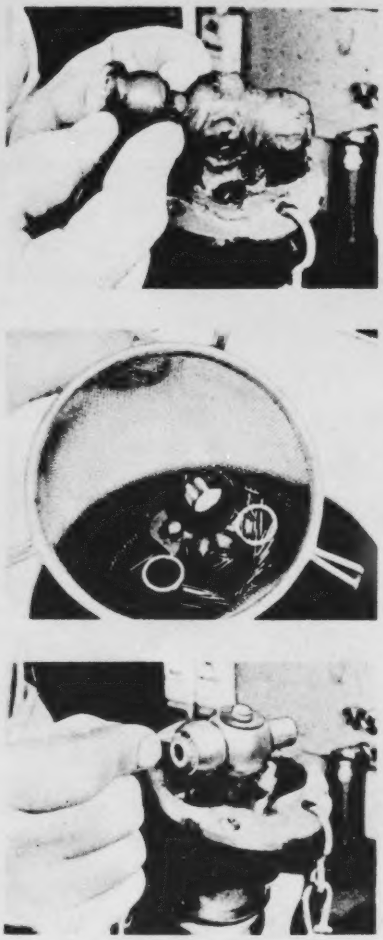


Fig. 29-9. Ball-and-trunnion U-joints can be hand-lubricated.

A hand gun is preferred for lubricating universal joints. High-pressure guns will likely damage the seals. If a U-joint is fitted with a plug, always reinstall the plug. If you put a fitting in permanently, you may unbalance the U-joint.

Universal Joint Disassembly

In older types where there is no permanent lubrication and no fittings or plugs, the universal joints must be disassembled for lubrication and service.

Cross-and-yoke types. These require exact reassembly to maintain balance. Mark the drive shaft ends and yokes with chalk line so you can match them up exactly. Remove the nuts and bolts holding the rear U-joint to the rear yoke on the differential. Tap the bearings gently to free them from the yoke. Then slide the shaft forward until it is free of the rear yoke, and again to the rear to free it from the front yoke. Do not let the shaft hang or drop. Remove it completely, and lay it to one side. Wrap the loosened bearings with tape to hold them together. Where a center U-joint is made into the shaft, it must be removed before the shaft is removed from the vehicle. Also remove the center shaft support from the frame. Retaining rings must be removed with special pliers made for that use.

Special tools are made for removing the universal joints and bearings. When disassembling, clean and examine the bearings for wear. Replace the entire bearing assembly if worn. Always replace the bearing shields, and repack the bearings with the proper type of lubricant. Reassemble in the reverse order.

Ball and trunnion types. Use a chalk line on the U-joint flange and matching flange of the differential or transmission housing. These must line up during reassembly to maintain balance. Remove the nuts and bolts from each universal joint, then remove the drive shaft.

Clamp the shaft in a vise. Do not put excessive pressure on the shaft since it is hollow. Be careful when removing the outer shell from the housing because there is a spring inside. Remove the spring assembly, then slide the trunnion pins outward. Remove the ball bearing assemblies from each pin, and inspect for wear or damage. Repack with proper lubricant, and reassemble in reverse order.

Constant-velocity type. Follow the same general procedure as in the cross-and-yoke type. Before removing the snap rings, put the joint into a vise, and mark each bearing cap and cross for alignment during reassembly. Follow the same inspection and lubrication procedure as for the other types.

Questions

1. When should wheel bearings be inspected and serviced?
2. What causes the lubricant to wear out in wheel bearings?
3. Briefly describe the disassembly and removal of front wheel bearings from drum brakes.
4. What is the major difference in removal of bearings from disc brakes?
5. What signs of wear are looked for when inspecting wheel bearings?
6. Name and describe the three common types of universal joints.
7. Why is a hand gun preferred for lubricating universal joints?

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Tire Service and Repair

Objectives: After completing this assignment, you will be able to—

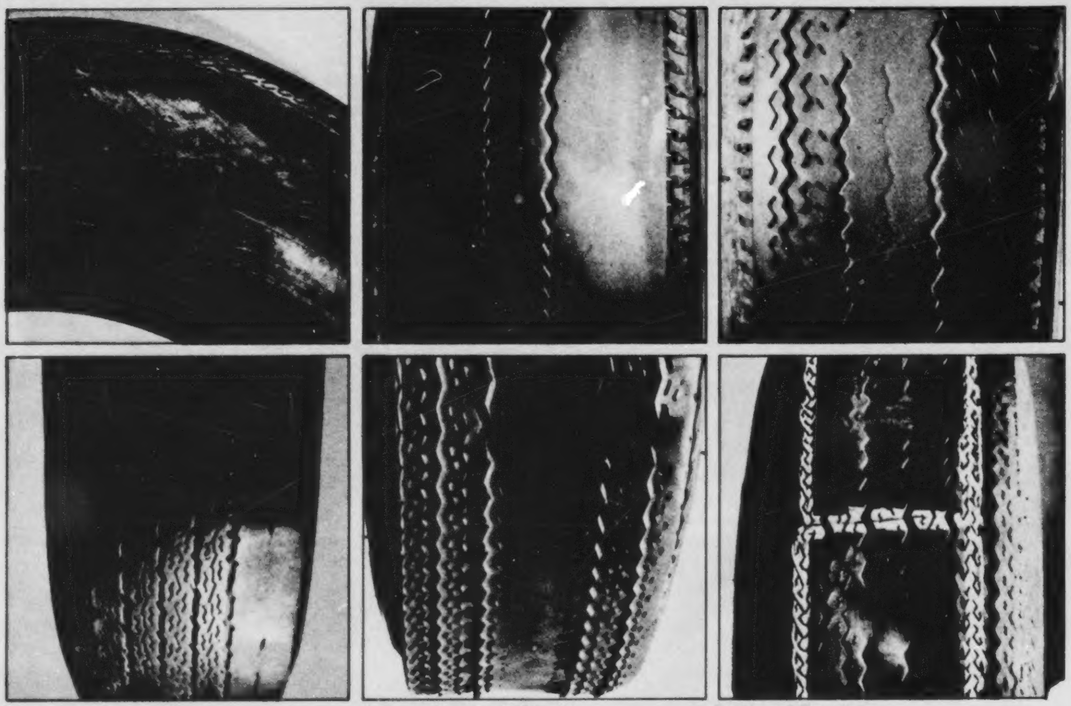
1. describe the conditions that cause excessive tire wear;
2. tell what kinds of repairs can be made on a tubeless tire;
3. describe the steps for repairing a puncture on a tubeless tire;
4. state safety precautions to observe when remounting a tire on a wheel; and
5. distinguish between static and dynamic balancing, and tell how to balance a tire and wheel.

Tire Inspection

To get maximum use and wear from automobile tires, they should be inspected often. Proper inflation, rotation, and examination for cuts and bruises will help maintain tires so that they perform well for maximum mileage. Your job in inspection is to examine the tires for proper inflation and signs of excessive wear that may be corrected. You should also look for signs that indicate possible tire failure in a short time (see fig. 30-1).

Tires should be inflated to the pressure recommended by the manufacturer under normal load conditions. *Underinflation* will cause excessive tread wear on the outer edges. *Overinflation* will cause excessive wear on the center tread area. Most motorists fail to keep a check on inflation, and unless you do it for them, they will not get the performance they expect and pay for.

Other excessive tread wear signs to look for are these (see fig. 30-2):



Separation Tread/Shoulder Area (Above Curb Rib)

Under Inflation

Over Inflation

Mechanical Irregularities

Misalignment of Wheels

Series of Breaks

Fig. 30-1. Examples of bad tires that should be replaced. (Courtesy Mobil Oil Corp.)

1. *Faulty wheel alignment* creates most of the excessive wear on tires. If tires are not at the right camber angle, uneven wear will appear either on the right or left side of the tread. *Camber* refers to the vertical axis of the tire. Positive camber will create unusual wear on the outer edge of the tread. Negative camber will create signs of wear on the inner edge of the tread.

2. *Improper toe-in and toe-out* makes a distinctive wear pattern that is easy to recognize. Toe-in and toe-out are the horizontal angles of the wheels. If either is not in exact alignment, then the tire is literally squirming itself to death by moving from side to side while rolling. The wear pattern shows up as tread ribs worn low on one side so it looks as if the tire tread is in a ragged pattern.

3. *Improper balance* on the wheel causes excessive wear. The tire will have cups or rounded depressions in the tread. It also produces excessive bounce and thumps when the car is being driven at highway speeds.

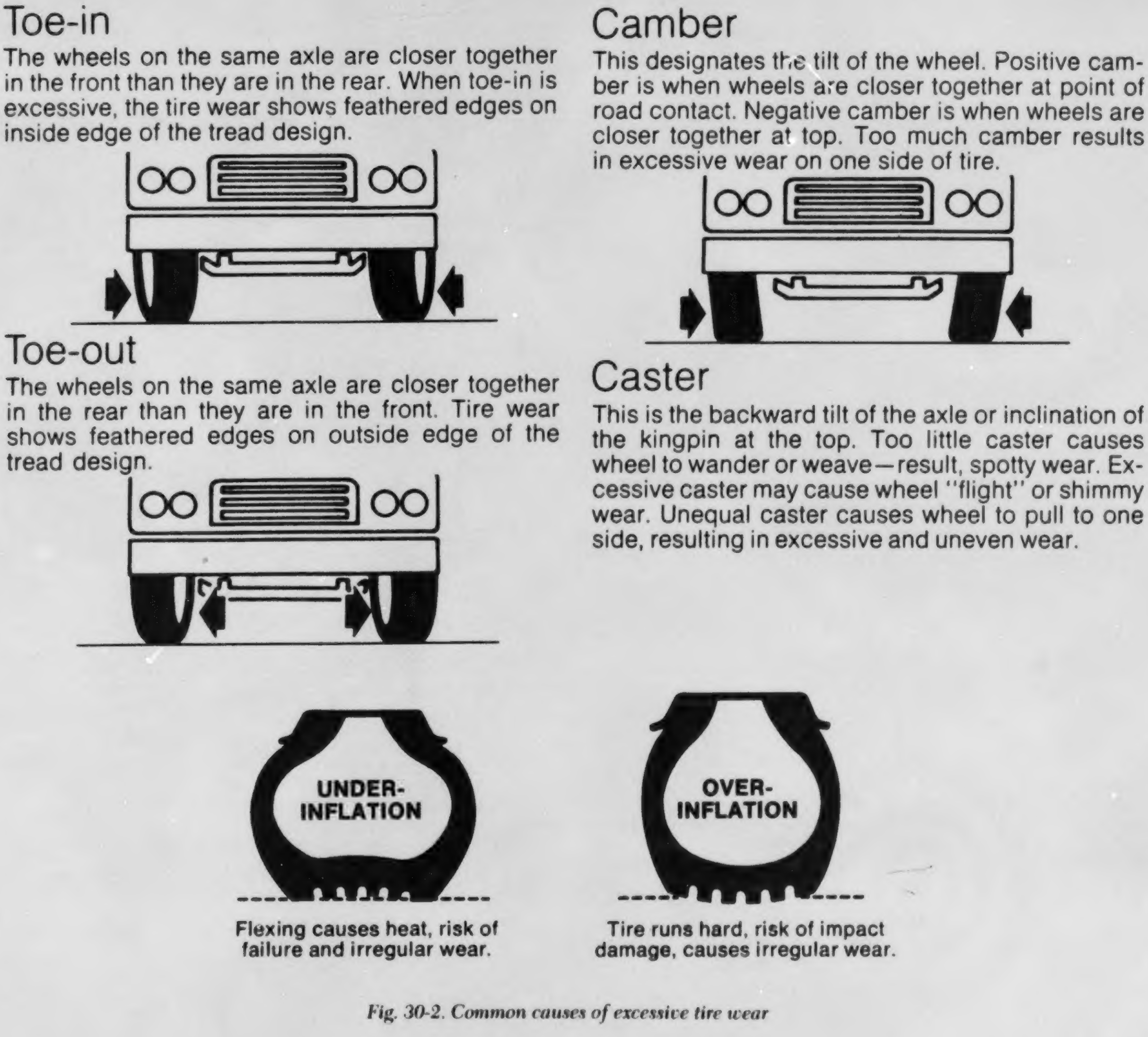
4. *Normal tread wear* will show a line across the tread when it is time for replacement. This bar is built in by the manufacturer. It shows the tire is in the last stages of safe tire life and will likely fail in a short time.

Also look for sidewall breaks, missing pieces of sidewall rubber with the cord showing through, and evidence of bruising. Look for bulges or any other abnormal signs that may indicate internal damage to the tire. Look for deteriorated or pinched valve stems that may begin leaking air. Look for missing lug nuts or loose lug nuts that can cause a serious accident.

Any evidence of excessive tire wear, damage, or possible tire failure should be brought to the attention of the motorist. In this way, you may be able to prevent accidents or at least a great deal of inconvenience from tire failure on the road.

Tire Repair

Nearly every place that sells tires also repairs and services them. The automobile owner expects this. Professional tire repair equipment speeds



Toe-in

The wheels on the same axle are closer together in the front than they are in the rear. When toe-in is excessive, the tire wear shows feathered edges on inside edge of the tread design.

Camber

This designates the tilt of the wheel. Positive camber is when wheels are closer together at point of road contact. Negative camber is when wheels are closer together at top. Too much camber results in excessive wear on one side of tire.

Toe-out

The wheels on the same axle are closer together in the rear than they are in the front. Tire wear shows feathered edges on outside edge of the tread design.

Caster

This is the backward tilt of the axle or inclination of the kingpin at the top. Too little caster causes wheel to wander or weave—result, spotty wear. Excessive caster may cause wheel "flight" or shimmy wear. Unequal caster causes wheel to pull to one side, resulting in excessive and uneven wear.

Flexing causes heat, risk of failure and irregular wear.

Tire runs hard, risk of impact damage, causes irregular wear.

Fig. 30-2. Common causes of excessive tire wear

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the work and makes it easier. However, you should know how to operate the equipment properly and how to make tire repairs.

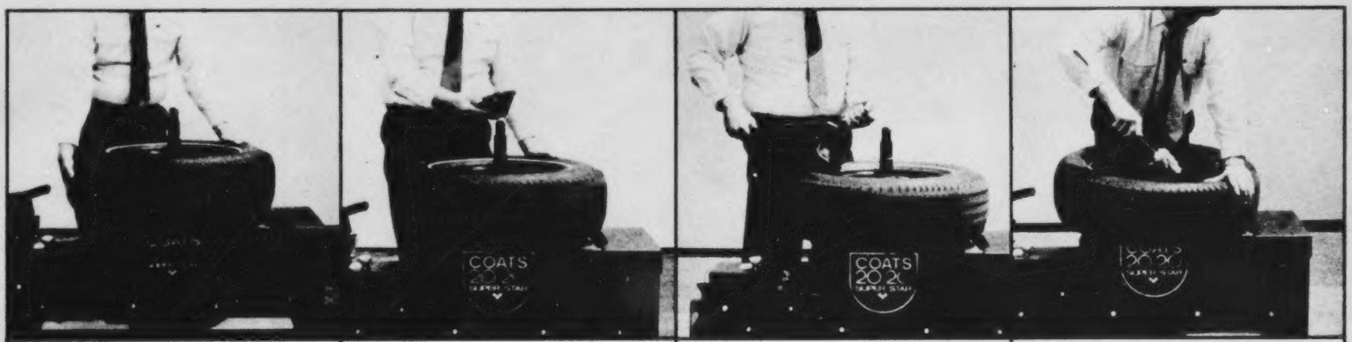
Tire Removal from the Wheel

Before placing the wheel and tire on the machine, remove the balance weights from the wheel rim. Use chalk to mark punctures or breaks so that they can be easily found after the tire is removed. Figure 30-3 shows the procedure for demounting tires.

Place the valve side up. This is also the narrow bead on the tire and the one that is easiest to remove. Screw down the cone over the wheel center, but hand-tighten only. Remove the valve stem *after* you have bled the air pressure from the tire.

Use the bead-breaking bar to insert under the lip of the rim and up under the tire bead. Center the bar on the post. Use tire lubricant to help break

Demounting Tires

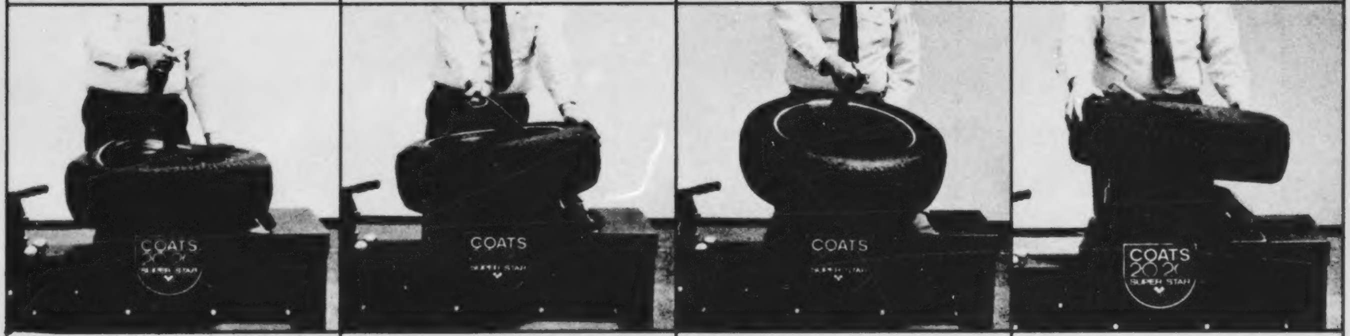


① Place tire in a horizontal position on changer, as shown here. Be sure that the low side of the wheel is facing up. Do not drop or throw tire onto the changer. Remove valve core.

② For your protection the tire should be securely fastened on the changer with the proper hold-down mechanism. In this illustration the hold-down is a cone which the serviceman is placing over the center shaft. Worn or damaged cones and shafts should be replaced.

Loosen the tire bead from the rim flange. This operation should be done carefully. If the bead does not readily separate from the rim flange, do not force or use a hammer. Apply additional lubricant and rotate tire to another position and try again.

④ After top bead is loosened from the rim flange, the inside of the wheel and both bead areas of the tire should be lubricated again. This makes it easy to remove the tire from the wheel without damage.



⑤ Use a recommended tire iron to bring the bead of the tire onto the rotating finger of the tire changer. Hold the tire bead in the center wheel well during this operation. Never use a pipe or make-shift bar.

⑥ Start the tire changer to remove the top bead from the wheel. Properly lubricated, the bead will slip away from the rim flange of the wheel with ease if the tire bead is held in the center well of the wheel, as shown.

Again lubricate the tire beads and bead seat area of the wheel, including the drop-center well of the wheel. This lubrication is necessary to enable the bead of the tire to slip down into the center well.

Use tire iron to raise bottom bead and bring it over the rotating finger of the changer. The side of the tire opposite the rotating finger must be down in the center well of the wheel and held in this position by the hip and left hand.

Fig. 30-3. Steps in demounting a tire. (Courtesy Mobil Oil Corp.)

the bead seal. Begin the circular swing of the bar to loosen the bead all the way around. The bead should now be above the rim.

Remove the tire completely from the rim of the wheel. It is ready for inspection and repair.

Making Repairs

On tubeless tires, repairs can only be made from inside the tire. If it is a puncture in the tread area, leave the nail or puncturing piece intact until you mark the puncture spot on the inside with chalk. Radial-ply tires can only be repaired in the center tread area. You cannot make a safe repair to the sidewall or side tread area. You can only repair punctures no more than ¼ inch in diameter. A hole or wound larger than that is not repairable. Long breaks, frayed areas, lost rubber, severe scuffs, and bruises cannot be repaired.

If the puncture is repairable, these are the steps you can use:

1. Clean the puncture area with solvent and buffer. Always buff and clean an area larger than the patch.

2. Use either a chemical or heat-vulcanizing patch. Cord plugs are not recommended except as emergency road repair. A small puncture hole can be plugged with rubber before being patched. Apply the patch over the puncture area. Use a tool to stitch or work down the patch, going from the center toward the outer areas. You must work all the air from under the patch to the outside, or it will soon come loose. The stitching tool also assures that the cement is completely covering the patch surface.

3. If a hot patch is used, follow the directions. You may use either an electric heating device or one that produces heat from burning with a match. Make sure you have properly prepared the area to be repaired before applying the hot-vulcanizing patch. Allow the patch to cool before removing the vulcanizing device.

4. Inspect the patch to make sure it is properly sealed all the way around the outer edges.

5. After patching, remount the tire, apply full air pressure, and check the patched area for leaks. A water tank is preferred for this. If an air leak is evident, then either you must apply another patch, or the puncture itself is not repairable.

Tire Mounting

Tire mounting applies to both new tires and repaired tires. Tire mounting is a little more difficult than tire removal from the wheel. First, inspect the wheel. Look for dents, warps, or other evidence of wheel damage. A damaged wheel will not properly seat and hold air pressure for the tire. If a wheel has been welded, it is possible that the welded seam may leak air. The wheel must be clean and free of caked dirt, mud, grease, or oil. Use a stiff wire brush to remove dirt from the rim where the bead will seat.

Place the wheel on the tire mounting machine with the valve side up (see fig. 27-4). Insert a new valve stem, using rubber lubricant to make it easier to mount. Screw down the holddown cone, and hand-tighten only. Lubricate both rims and both beads of the tire to be mounted. If mounting new tires, make sure the wheel balance weights have been removed from the wheel rim.

Place the tire on top of the rim and at a slight angle. Force the lower bead around the lower rim as far as it will go. Use the special bar for remounting and put it on the center post. Swing the bar around so that the top bead is below the wheel rim all the way around. Inspect to make sure both beads are on the rim.

Inflate the tire to the proper air pressure. If there is too much space to let air escape, then you must use a tightening device to hold the tire up to the wheel until it is inflated. **CAUTION: Keep your hands and fingers away from the rim and bead while inflating.** Most tires will pop suddenly to the wheel surface and can severely smash your hand and fingers. Also, do not lean over a tire while inflating. Most tires will be fully seated at about 30 psi. You can go as high as 40 psi if necessary, but do not exceed that amount. If the tire does not seat at 40 psi, then something is wrong. The tire is oversized for the rim, or there is a leak.

Check the wheel and tire for excessive runout before remounting on the vehicle. Sometimes a new tire can be out-of-round or have a manufacturing defect that makes it unsuitable for balancing. Radial runout is measured in the center tread area of the tire. If it is excessive (more than 0.125 inch), the tire will not balance. A bent or warped wheel can be measured on the upper rim area just above the tire bead. An excessive runout here can also mean the tire will not properly balance.

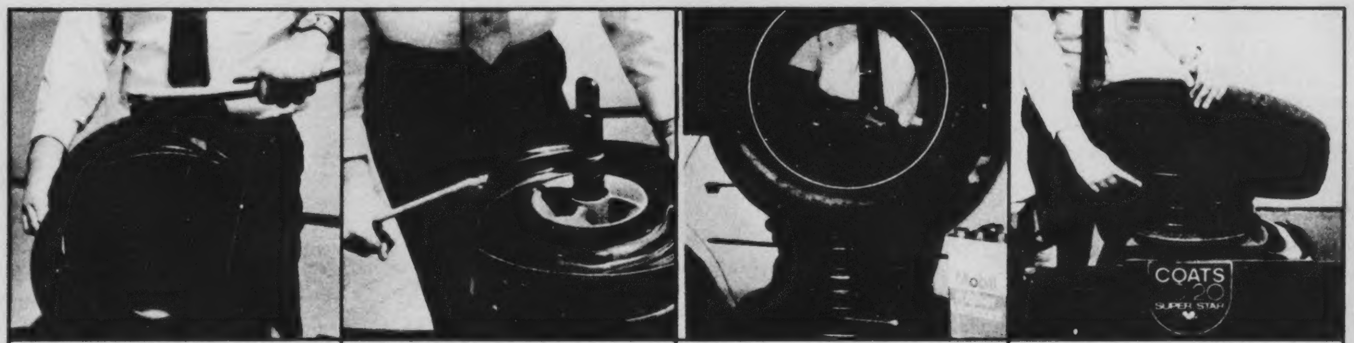
Tire Balancing

When a tire is repaired or when a new tire is mounted on a wheel, it should be balanced with the wheel. Wheel balancing makes the tire wear evenly and produces a quieter, easier ride. It is almost impossible to manufacture a tire that is in perfect balance with every wheel. Each type of wheel balancing equipment is slightly different, and you must follow the manufacturer's directions for its use.

There are two types of balancing—dynamic and static. *Static balance* refers to the weight of the tire. That is, there is no heavy spot, and the tire is balanced evenly around the hub or axis. Heaviness will produce a rough, uneven ride with too much wheel bounce. *Dynamic balance* refers to equal weight on both the inside and outside circumference. If you stand a tire vertically on end and imagine a spot on the upper left side and a spot on the inner right side that are not even, the wheel will wobble from side to side. Dynamic balancing takes care of this problem. A tire that is not dynamically balanced will show excessive wear on half of one side and half of the other side of the tread area.

Both types of balancing can be done by placing lead weights around the outer rim area of the wheel. Two basic types of balancing equipment are used. *Spin balancing* is done with the wheel and tire on the car. *Bubble-type balancing* equipment places the wheel and tire on a horizontal plane off the car. It does static balancing only. Spin balancing can correct both dynamic and static problems.

Tire Mounting and Inflation Safety Precautions



●

Be certain that rim flanges and bead ledge (especially hump and radius) areas are smooth and clean. Remove any oxidized rubber, dried soap solution, rust, heavy paint, etc., with a wire brush. If a rim is bent or damaged it must be repaired or replaced.

●

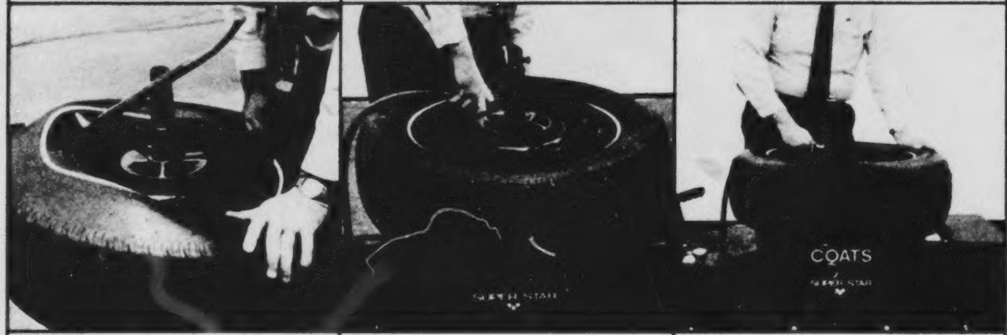
With the narrow bead ledge up, securely fasten the rim to the mounting machine. Insert snap-in valve. Always install a new valve stem when mounting Radials. All valve stems should be installed with a valve tool and the valve core should be properly inserted into the stem. Always lubricate the valve.

③

Lubricate the tire beads, rim flanges, and bead ledge before mounting with approved mounting solution preferably with Mobil Non-Oil Based Lubricant.

④

In mounting the tire, push the bottom bead in the well of the wheel, as shown here. Be sure there are no tools or foreign objects inside the tire casing. The tire must be slipped on over the low side of the wheel.



●

Push the top bead down into the center well of the wheel. Hold the tire in this position while the rotating finger runs the bead onto the wheel.

●

Inflate the tire with valve-core in place. If beads do not seat with 30 psi, slowly increase pressure to a maximum of 40 psi.

⑦

If beads have not seated by the time pressure reaches 40 pounds, deflate the assembly, reposition the tire on the rim, re-lubricate and re-inflate it. After seating bead, adjust inflation to recommended pressure.

If a rim is dirty or corroded, or if the tire is not centered on the rim, the tire bead may 'bind' on the rim and refuse to seat. Allowing air pressure to build within the assembly in an attempt to seat the bead is a DANGEROUS PRACTICE.

To make sure mounted tire has no air leaks, submerge the tire and wheel assembly in a water test tank. Leaks around base of a metal valve may be corrected by tightening the hex nut. If a rubber valve leaks at the base, replace the valve. Leaks through the core may be corrected by tightening or replacing core if defective. Leaks around rim rivets and wire spoke wheels require demounting. Special rubber-to-metal cements are available for sealing leaks around rim rivets. In no case should rims be welded or brazed.

Do not stand over tire while inflating it!

DO NOT EXCEED 40 PSI

Fig. 30-4. Tire mounting precautions. (Courtesy Mobil Oil Corp.)

Tire Rotation

For maximum wear, tires should be rotated every 5,000 miles. The spare tire can be used in the rotation system to achieve even longer mileage. Since front tires receive the greatest amount of wear, their life is increased by rotating them to the back and to opposite sides. This reverses the tire rotation so that a set tread pattern is not built in. However, radial-ply tires should not have reverse rotation. Once set, they should revolve in the same direction. On radial-ply tires, you rotat from front to back on each side, but do not switch sides (fig. 27-5). On bias-ply and bias-belted tires, rotate front to back and from one side to the other, as shown in figure 27-6.

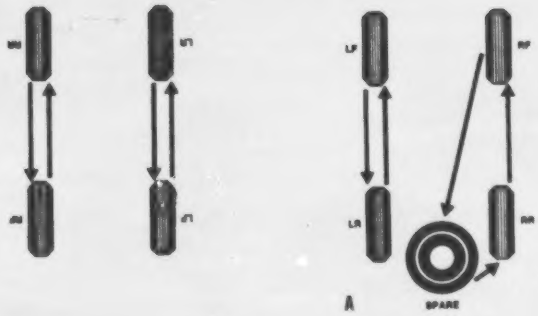


Fig. 30-5. Recommended rotation for radial ply tires. (Courtesy Mobil Oil Corp.)

Questions

1. What two conditions cause the greatest majority of tire wear problems?
2. What are the indicators of over-inflation and underinflation?
3. What are the indicators of positive and negative camber in wheel alignment?
4. If the toe-in or toe-out is incorrect, how can you spot the problem on the tire tread?
5. How can you tell if a tire is in the last stages of its normal life?
6. What kinds of damage can be repaired on tubeless tires?
7. What are the steps for repairing a puncture on a tubeless tire?
8. What safety precautions should you observe when remounting a tire on a wheel?
9. Why is it desirable to check for runout on a tire and wheel before remounting?
10. Distinguish between *static* and *dynamic* balancing.

Project

If your training station has balancing equipment, give the procedures for its use and how you balance dynamically and statically. Describe the sizes and types of weights used and how you place them to achieve balance.

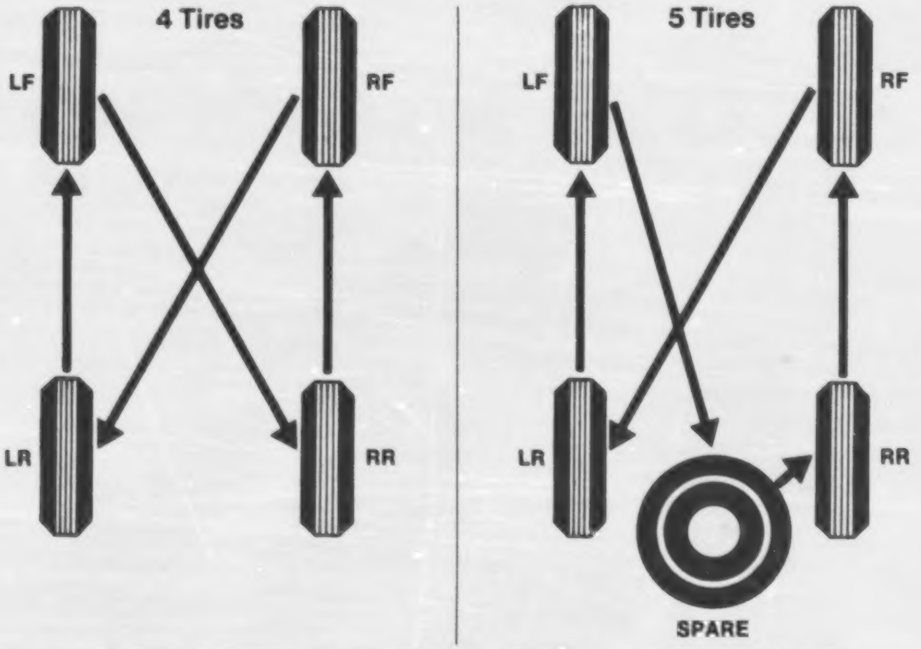


Fig. 30-6. Recommended rotation for bias-ply and bias-belted tires. (Courtesy Mobil Oil Corp.)

31

Customer Relations

Objectives: After completing this assignment, you will be able to—

1. explain the difference between a "people business" and a "products-service business";
2. tell why good customer relations are essential for a marketing business;
3. explain why you should never hesitate to sell;
4. name guidelines for handling customer complaints;
5. tell how you can avoid having customer problems; and
6. tell why service stations are a part of the local community's hospitality industry.

What Are Customer Relations?

Someone once defined *customer relations* as "relationships with customers." That doesn't tell us much about it, though. Let's take an imaginary trip through town and ask several different store owners, managers, and salespeople about the kind of business they're in.

The first stop is a service station. We ask a driveway attendant, "What business are you in?"

"We are a service station. We sell gasoline, oils, lube jobs, tires, batteries, and just about anything the customer wants."

Out next stop is a retail tire and auto products company with a well-known national name. We ask the manager what business she is operating.

"We are Southern Auto and Supply—the nation's largest distributor of Ajax tires, batteries, and accessories. We keep America's cars rolling."

Our next stop is a franchised automotive products and hardware dealership. We ask the owner what business he is operating.

"We are primarily an automotive supply house. We cater to the very big auto replacement market, and we do quite well. We also sell another line of home products and tools—basic hardware items that customers buy while their car is being serviced. But I guess you could say we are really in the automobile business."

Our next stop across town is a wholesale petroleum products jobber. Our question is the same, "What business are you in?" The answer this time may be a bit surprising.

"I am in the *people business*. You see, I operate a wholesale jobbership and we do sell many products, but I consider that my real business is pleasing my customers and taking care of their needs. I am in the human relations business, and petroleum products are my sideline."

This last person has the right perspective and the right attitude. It is surprising how many marketers forget that their business is really people—and that products and services are their sideline.

The truth of that statement comes from this assumption. You may sell products and services for automobiles, but your business is people. People work, have jobs, make an income. People drive automobiles. People make buying decisions—not their cars! The automobile is just a machine. It has needs, but it does not make buying decisions. It cannot be insulted, ignored, treated shamefully, nor does it respond gratefully to a smile and a cheery "Good morning." People do respond. That is the substance of customer relations or human relations.

The Need for Good Customer Relations

The business you are in is highly competitive. Your competitors also sell good-quality products and provide about the same services. The only thing you have to offer to build a good customer clientele is customer relations. People return to places where they get personal attention and a friendly, helpful attitude. It is the steady repeat customer who builds your business. You can sell almost everyone a product at least once. But after that, what do you do? You must do something to bring them back to you on a regular basis.

Good customer relationships are built on these:

- Personal attention to needs.
- Treating each customer as an individual with individual needs.
- Giving an extra measure of service.
- Constant contact with the customer by telephone or mail.
- Showing the customer *why* a product or service is needed.
- Letting the customer know that you care.

- Making the customer feel that he or she is wanted, needed, and appreciated.
- Taking immediate steps to correct an unsatisfactory purchase or poor service.

It does little good if only the manager or owner feels the need for customer relations. It must be a part of every employee's daily job responsibility. Each employee who has contact with the customer must feel the need to treat the customer right and make every transaction satisfactory. Small things will be overlooked by the customer who is treated courteously and with a helpful, friendly attitude.

Never Hesitate to Sell

Many people mistakenly believe that the customer does not want to be "hassled" with a selling effort. Yet your business is to sell products and services that the customer *needs* for his or her automobile. Customers expect to be sold and to buy. Most customers do not know what they need in the way of automotive products and services, and they depend on you to tell them. If you wait for the customer to ask, then you are allowing the customer to drive away with unfilled needs.

The rule in the automotive replacement/service market and petroleum products market is to *show and sell.* Show the customer the need, and tell him or her why it is needed. Point out safety, performance, improved operation, improved gasoline mileage, comfort, better handling and control, the manufacturer's recommended service intervals, and what will likely happen if the car goes too long between needed services.

Sell the idea of regular scheduled maintenance and service. Sell the idea of regular system inspection and what it will do for the customer. Tell the customer the benefits of regular scheduled maintenance. Sell the idea of keeping records and notifying the customer, and of making appointments so there won't be a lengthy wait or delay.

Sell the idea of personalized, customized service. This is what the customer wants and needs.

Handling Customer Problems

If you do a good job of selling customers on regular scheduled maintenance and inspection, you cut down on customer problems. If you are selling good-quality products and giving expert services when needed, then you are much less likely to find customers complaining. Rather, they will be complimenting you for taking care of them. However, even the best products sometimes fail, and even the best employees sometimes do things in a hurry or fail to notice little things. These cause or bring on customer complaints. Regardless of who is at fault, you must try to resolve customer problems in the most satisfactory manner. You never win an argument with a customer.

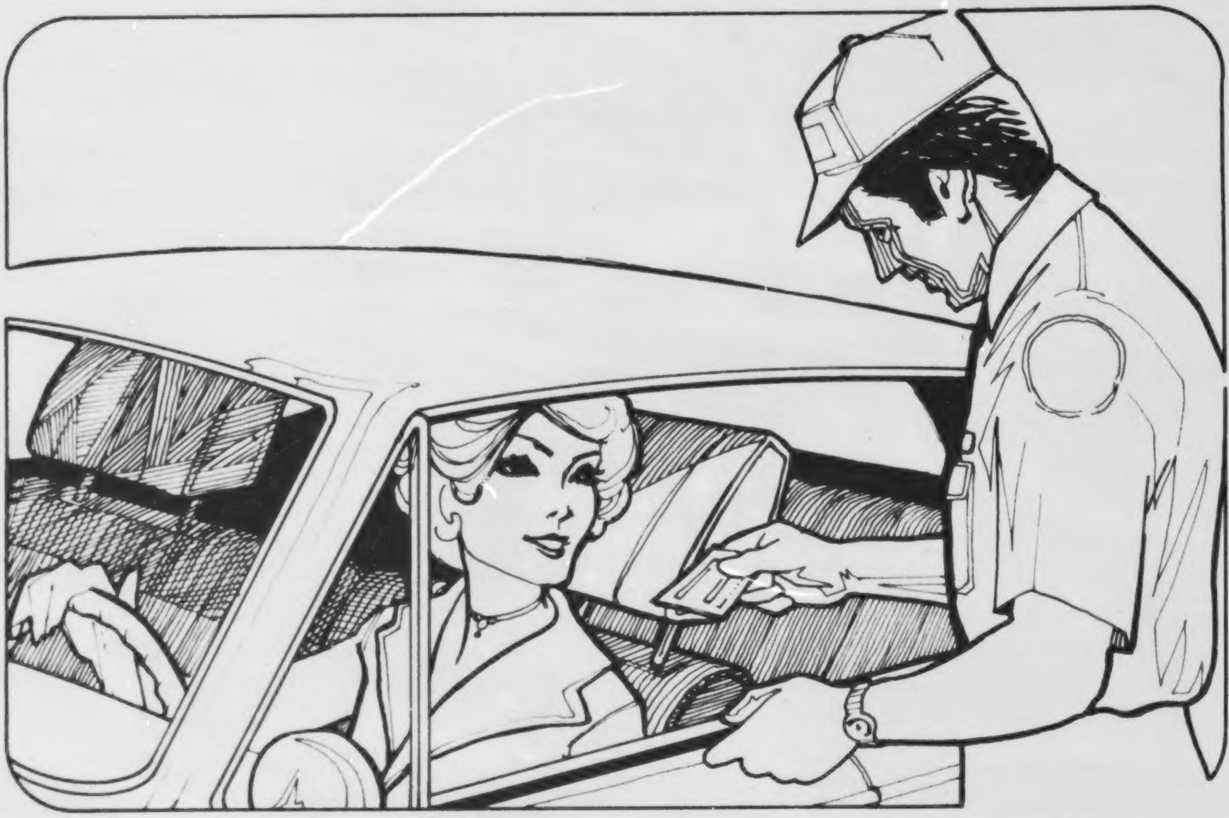


Fig. 31-1. The substance of customer relations is pleasing customers and taking care of their needs. (Courtesy Mobil Oil Corp.)

When the customer has a complaint, follow these guidelines:

1. Listen to what the customer is telling you—even if you think the customer is wrong or unfair.
2. Let the customer know you are genuinely interested in her or his problem.
3. Tell the customer you will try to find the cause and offer a solution.
4. Investigate and get correct information before you take action.
5. Determine a solution that will be best for the customer and for you.
6. Don't keep the customer guessing as to what you will do. Do it now.
7. If you can't handle the complaint, turn it over to the person who can.
8. Don't make promises to the customer that you can't keep.
9. Remember that, in solving customer problems, your overall objective is to make the customer happy and keep him or her coming back.
10. Most customers will respond to a reasonable offer, particularly when you show and explain the situation.

Avoiding Customer Problems

The obvious, best solution to solving customer problems is to prevent them from happening in the first place. Good-quality work and good-quality products will lessen the likelihood that customers will have reason to complain. All service and repair personnel should follow these guidelines in their work:

1. When you make repairs or render a needed service, do the job right.
2. Never let time or other jobs keep you from doing a good, thorough job.
3. Remember the customer's safety.
4. Remember your responsibility to the customer.
5. Always call a weak or worn part to the customer's attention, and suggest the possible consequences.

Answering Specific Complaints

Often a customer will make a statement that is worded as a complaint, but is actually an opportunity to give additional service. That is why it is so important for you to *listen sympathetically* to what the customer says. In many cases, the customer is asking for additional information. Here are some examples.

Customer: "This oil of yours just isn't working in my car. I'm using a quart every thousand miles. It never used to burn that much."

The customer is giving you a statement of fact that is worded in the form of a complaint. It is up to you to answer the question and find a workable solution. You should question the customer about the kind and weight of oil previously used. It may be that he or she asked for a multiweight oil that is not satisfactory for the

Fig. 31-2. Never hesitate to sell. (Courtesy Mobil Oil Corp.)

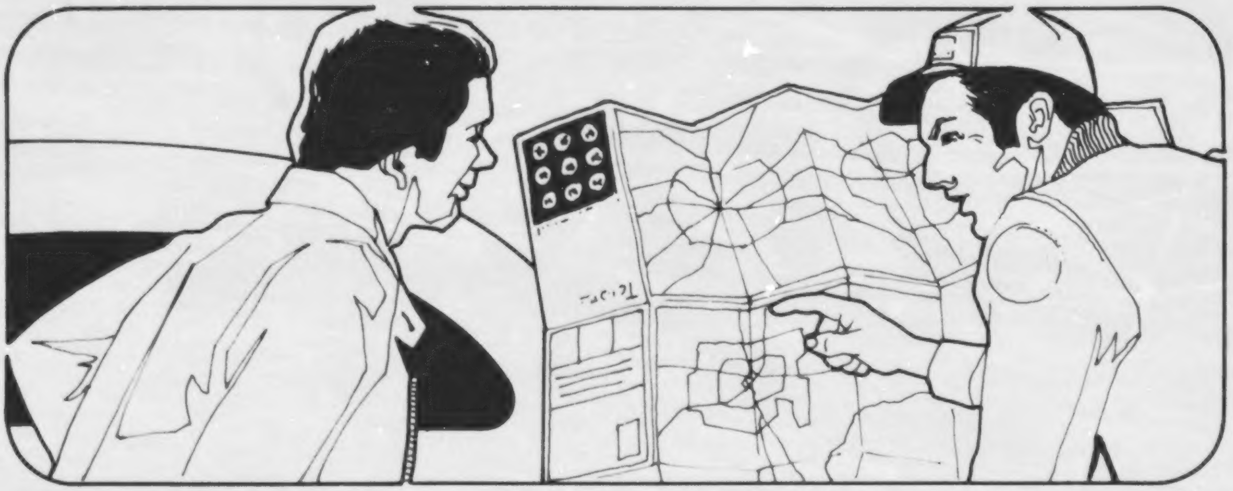


Fig. 31-3. Giving directions and pointing out places of interest is part of goodwill. (Courtesy Mobil Oil Corp.)

particular engine. Suggest that the customer return to a single-weight oil. First, reassure the customer that your oil is of the highest quality and that often oil usage can be attributed to other mechanical factors. Ask to check the engine for possible leaks around gaskets and seals, an oil filter that is not properly seated, and a number of other factors.

Customer: "I bought a set of tires from you back in the summer. Just look how fast they're wearing. I think you sold me a bad set."

Again, the customer is making a statement of fact that appears to be a complaint. You job is to investigate and find out why the tires are wearing or showing signs of wear. It may be an alignment problem or any of a number of mechanical difficulties. Assure the customer that the tires are of specified quality, and what kind of mileage rightfully can be expected. Ask about mileage, driving conditions, driving speeds, road conditions, and other factors that can affect tire performance. If the customer is thoroughly dissatisfied, offer a reasonable trade-in on a higher-quality tire with a longer mileage guarantee. Take care of any mechanical problems that may be affecting tire life.

Customer: "You know that 36-month battery I bought a few months ago? It wouldn't start this morning. I've only had it 8 months. It must have been bad when you put it in my car."

The customer wants answers to questions, and wants some satisfaction. First, assure the customer that you will make a complete inspection and will give a satisfactory adjustment. Don't assume that the customer is at fault or that the battery itself is the main problem. Many things can cause a weak battery. It could be poor maintenance on the battery. It could be corrosion, a poor connection, a weak starter, a drain on the electrical power through a short circuit, cold weather (which drains a battery's starting power), or a bad charging circuit. You need to check out the car's various systems and the battery itself before you decide on the proper action and adjustment to take.

Building Customer Goodwill

Retail petroleum marketers are a part of any community's hospitality industry. This includes hotels and motels, eating and drinking establishments, personal services, as well as service stations. The reason is that visitors to a community most often stop first at a service station. They stop for several reasons: (1) to use the rest room facilities, (2) for snacks and refreshments, (3) for needed car service, (4) to ask directions, and (5) to ask about specific local points of interest.

Friendly, helpful service is an absolute must. You should also be well acquainted with the local community. You should know the geography of the area—particularly the major highways and where they lead. Nothing is worse for goodwill than giving a stranger the wrong directions, or not giving directions at all because no one knows. Most service stations have a supply of state and area maps as well as local maps. These were once given away, but now there is a charge. Even so, maps can be used to build goodwill and to offer helpful information for those who are lost or who are strangers to the area. Use maps to show local sites, buildings, parks and recreation areas, hospitals, churches, and other places of local interest.

Maintain clean rest rooms and rest facilities. If your station has a vending area, keep it clean and free of trash and clutter. You must have a clean, well-lighted, well-maintained facility. A service station attracts by its physical appearance. Buildings and equipment that are poorly lighted and look rundown, like an automobile junkyard, are an eyesore. Not only does the business not attract customers, but it is a negative image for the neighborhood and community. Service stations can be either a positive image or a negative image of an entire neighborhood and business district.

Questions

1. Explain the difference between a "people business" and a "products-service business."

2. Why are customer relations a very necessary part of each business?
3. Name eight ways that good customer relationships are developed.
4. Why should you never hesitate to sell to the customer?
5. What are ten guidelines for handling customer problems?
6. What are some ways that you can avoid having customer problems?
7. Why are service stations a part of the community's hospitality industry?
8. What are some ways that service stations can develop goodwill for the community?

Project

Following the guidelines suggested in the text, tell how you would handle each of the following customer complaints. Use your training station's guidelines if they have been given to you.

(1) "I bought this set of tires a month ago and have had my second flat tire. I bought new tires to keep from having flats."

(2) "You installed a set of shock absorbers on the front end a while back. My car still rides rough. They must not be any good, and I want my money back."

(3) "I bought white sidewalls because they were on sale. They are too hard to keep clean. I want to trade them in on blackwalls."

(4) "I had my oil and filter changed here last week, but they didn't put on a new filter even though I was charged for it."

(5) "I left my car here for service last week, and you guys put a big dent in the right rear fender section. What are you going to do about it?"

Objectives: After completing this assignment, you will be able to—

1. tell why full stocks increase sales and profits;
2. describe a perpetual inventory system, and tell how it operates;
3. explain stock controls on gasolines, motor oils, tires, and other costly items of merchandise;
4. explain the importance of measuring stock turnover; and
5. give the formulas for measuring stockturn and capital turnover.

32

Stock and Inventory Control

Need for Adequate Inventory

"You can't do business from an empty wagon" was the motto of the rural peddler of a century ago. In the same way today, you can't provide the needed products and services to customers unless you have complete stocks. The variety, depth of assortments, price ranges, and amount of inventory that you have on hand largely depends on the type of business you have and the number of customers served during the year.

Today, inventory is a sizable dollar investment. If you tie up your dollars in stock that is not selling, then you are wasting money. On the other hand, if you have too little inventory on hand, you are losing profitable sales. Those sales and customers are going to your competitors. It is a situation where too much or too little can kill you, and only the successful merchant will know how much. One solution to this critical problem is a good inventory control system.

Benefits of Adequate Inventory

The successful merchant has learned what to buy, when to buy, and what amounts of each item to buy. All three are critical in maintaining an adequate inventory with the minimum dollar investment. Buying is done on a budget, and that is determined by the previous sales by seasons. It is crucial to a full selling effort to have an adequate inventory on hand at all times. These are the advantages of having a full inventory:

1. You can give more efficient service because you have on hand what you need. If an employee must be sent to buy a part or product somewhere else, this is expensive and time-consuming, eating up what little profit may have been made.

2. Customers want to shop where there are adequate stocks of parts and products they need. Full inventories indicate a healthy, thriving business. Partial stocks or half-full shelves show poor business activity, and the customer loses confidence in the operation.

3. Employees do a better job of selling when they have full stocks to sell from. The more variety and assortments on hand, the greater the sales motivation.

4. Full stocks mean that you lose fewer sales. An efficient control system assures that your on-hand inventory is always adequate.

5. Fully stocked shelves are more attractive and inviting to customers.

6. Fully stocked shelves actually reduce losses because they are easier to inventory and shoplifting is discouraged.

7. Full stocks improve cash flow because the only items in stock are those with an adequate turnover and profit potential. Good controls reduce or eliminate slow-moving items and profit-losers.

8. Full stocks reduce labor costs because needed items are on hand and service personnel do not have to wait on delivered items.

Stock Control Methods

The easiest way for most merchants to increase their net income is to develop a practical system of inventory control that best fits the individual business. The following ideas can be adapted to each business, depending on its size, type of ownership, and sales volume.

Gasolines and motor fuels. Almost every dealer who dispenses motor fuels by the pump from an underground storage tank has some type of daily report form. It is recommended that tanks be gauged or measured daily. Even though the pumps have a meter to measure gallons and dollars, the tanks need to be measured. The daily measurement is then matched with the pump reading to see the amount of shrinkage or loss. Some loss, of course, comes from evaporation. Also, there is a chance for error on the pump reading, and some fuels can be polluted with water condensation.

Repeated or consistent errors in pump readings mean that the pumps themselves are inaccurate and need service and adjustment. It may also mean some pilferage is going on—that gasoline is being pumped that is not being paid for.

With the continual increase in costs of motor fuels, substantial gallonage losses can ruin the profits of an entire day or more. Another method of testing the accuracy of the pump register is to dispense gasoline and motor fuels into accurately measured containers. After a pump register has been serviced by the authorized service person, the pump must be certified by an official from the state's department of weights and measures.

Daily stick readings will also assure that you know when each grade or tank is getting down to the reorder point. Again, spot shortages of fuels make it even more crucial to order fuels well in advance of need to prevent out-of-stocks.

Motor oils. Since most dealers of motor oils, particularly those with service bays who do a large volume of oil changes, have a large daily turnover, daily inventory is recommended. The same is true for oil filters and automatic transmission fluids.

In the service bays, sales by units and dollars are recorded on the job tickets. These can be transferred at the end of the day to the inventory or ledger cards. Oils sold at the pump island are more difficult to keep track of because employees do not always separate items by cash sales. The total amount is registered, and without some type of invoice system, oil sales are lumped with motor fuel sales. A better and more accurate way to inventory is to check out the oil can racks and take a physical count at the end of each day. Or, simply fill the island racks from the storeroom, and make a count at the end of each day for total sales. If oil is dispensed from a single storeroom source, then the reserve stock is counted each day and tallied with those from the shelf as well as island racks.

Motor oils and transmission fluids, as well as filters, should be tallied by classification and brand name for the most accurate inventory. This way, you can more accurately reorder only those items that need restocking. If oils and filters are stocked by classification, brand, and type, the daily inventory will be easier and more accurate.

Greases, gear oils, lubricants. Since these items are dispensed from bulk containers, it is not necessary to try to measure the on-hand amounts. It is usually a good idea to reorder a new drum of these lubricants as soon as one is opened. This assures always having enough on hand without being overstocked. The costs of lubricants are accounted for in the charges on the job tickets. Since labor and materials are not separated in a lubrication job, the costs of lubricants are charged as an expense rather than a product cost.

Tires, batteries, and similar accessories. Inventories of tires and batteries can be rather extensive. The amount of on-hand stock is largely determined by the volume of sales in each category. A large sales volume means a large on-hand stock at all times. The reverse is true for lower sales volume.

Because of the comparatively large amount of money per unit invested in tires and batteries, it is necessary to take an on-hand inventory each day. One missing or lost item means a substantial loss of money. A great deal of security is required in stocking these so that control is as tight as possible.

Tires have stock numbers or registration numbers, and these should be on the inventory form. A daily count shows how many tires should be accounted for on the sales slips of the previous day. Only by checking the inventory form against the daily count can management exercise close control.

All other products. Other automotive products should be treated the same way as any other stock. Expensive items—such as tools—should be inventoried or counted daily. Others will require a weekly or monthly control count. All items should be inventoried monthly.

A Perpetual Inventory System

What the System Does

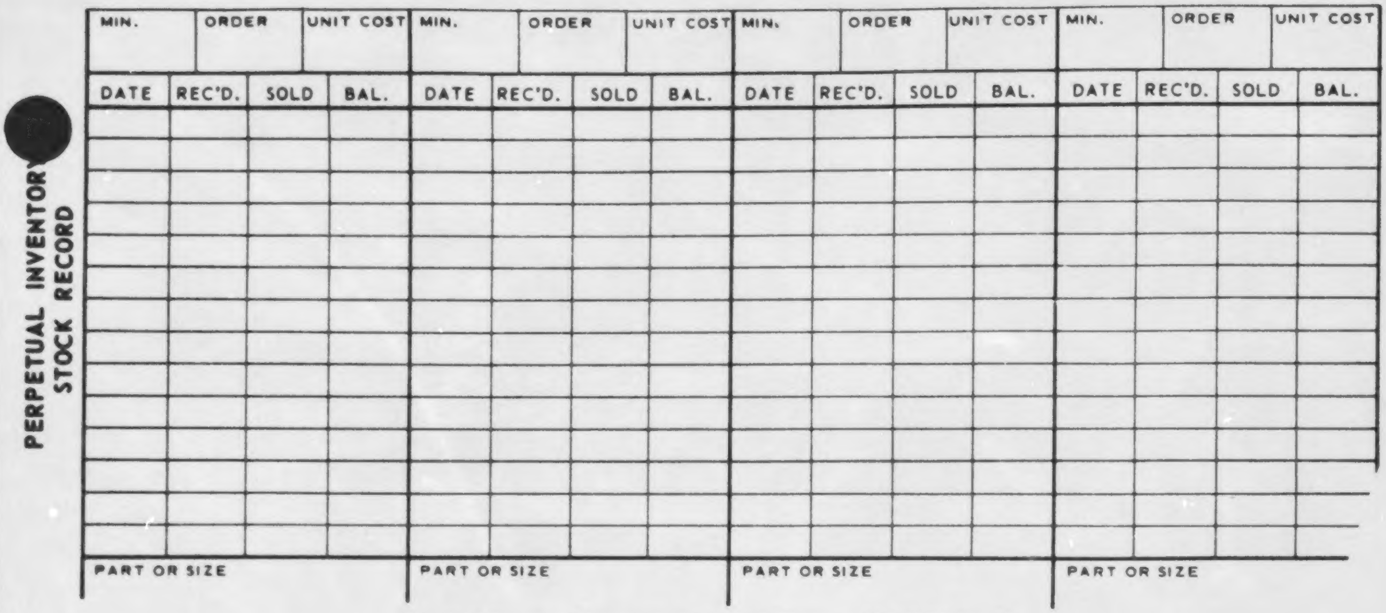
A perpetual (meaning *ongoing*) inventory system is simply a means of stock control. It gives management a system whereby stock can be accounted for in a manner that has been proven by years of experience. Nearly every marketing enterprise uses some sort of perpetual or ongoing system of stock accounting. Each item is assigned a stock number, a cost code, a receiving date, and count. This information is put onto a card or inventory form. A sample is shown in figure 32-1. In addition, for fast-moving items, a minimum on-hand figure is indicated. For example, when a 3-ounce can of penetrating oil reaches eighteen on hand, an immediate reorder is issued. This figure is determined by the average unit sales per week, and the number of weeks it takes to get the item back from the supplier.

At least once a month, the book inventory is checked against the actual inventory or physical count. If the book number and actual number agree, then the control system is good. If there is less on hand by physical count than the book inventory shows, then a shortage exists. This means that either (1) items are being shoplifted or taken by employees, (2) items are being sold but not properly accounted for on invoices or cash register, or (3) items are being miscounted or mishandled by employees. It could be a combination of these, but at least management knows the system is not working properly. Management can then find out what is happening and take steps to better control the inventory.

Advantages of the System

A perpetual inventory system has specific advantages. Once set up, and used, the system is automatic. Here is what it will do for management in stock control.

1. Counts can be made at any time and as often as needed. Spot checks can be made on selected items. Fast-


PERPETUAL INVENTORY STOCK RECORD

MIN.	ORDER	UNIT COST		MIN.	ORDER	UNIT COST		MIN.	ORDER	UNIT COST		MIN.	ORDER	UNIT COST	
DATE	REC'D.	SOLD	BAL.	DATE	REC'D.	SOLD	BAL.	DATE	REC'D.	SOLD	BAL.	DATE	REC'D.	SOLD	BAL.
PART OR SIZE				PART OR SIZE				PART OR SIZE				PART OR SIZE			

Fig. 32-1. Perpetual inventory stock card. (Courtesy Mobil Oil Corp.)

moving merchandise is checked more often than usual to make sure you have no out-of-stock conditions.

2. Inventory can be taken at the convenience of management. Employees can be scheduled to take counts during slack times.

3. Sales and book inventory counts should agree with physical counts. Any variation shows up immediately, and management can take steps to find out why.

4. The system is foolproof as long as it is used as intended. It is simple and easy to operate without a great deal of training.

5. Overstocking and understocking are less likely. Slow-moving items need a reduced on-hand supply. Fast-moving items need more. Management has better control of money invested in stock or inventory.

6. You know the cost value of each item in stock at its most recent value. You can easily tabulate the total amount invested and the total value of inventory at its retail price.

7. Accounting is simple, and the sheets are easily tabulated. Figures are transferred to accounting journals and ledgers for tax purposes.

Setting Up the System

The only difficult or time-consuming part of a perpetual inventory is preparing the sheets or forms and organizing them into a set of books. While there is no best way, guidelines will help you determine how it can be done. Of course, any system must be tailored to the individual business it serves. Large sales volume organizations use computers; smaller businesses use a hand-tallied book. There are many variations between these two extremes, but the system has to work for the business operation.

Step 1: Prepare a sheet or card *for each item* carried in stock. For example, D-size flashlight batteries have a card entry, and C-size batteries have a separate card. You would not prepare a single sheet for all flashlight batteries since the sales rate and unit prices would be different.

Step 2: Determine the minimum on-hand stock before reorder and the number you wish to reorder. Minimum stock is determined by (1) the time required to get the item back in stock from the supplier, (2) the average sales during that period, and (3) any anticipated increase or decrease in demand during the period. Your objective in setting minimum and reorder amounts is to never be out-of-stock or overstocked *unless* an exceptional buy can be made.

Step 3: For each item, make the first entry the number presently on hand and the date counted. Each order that is received is entered in that column and added to the balance.

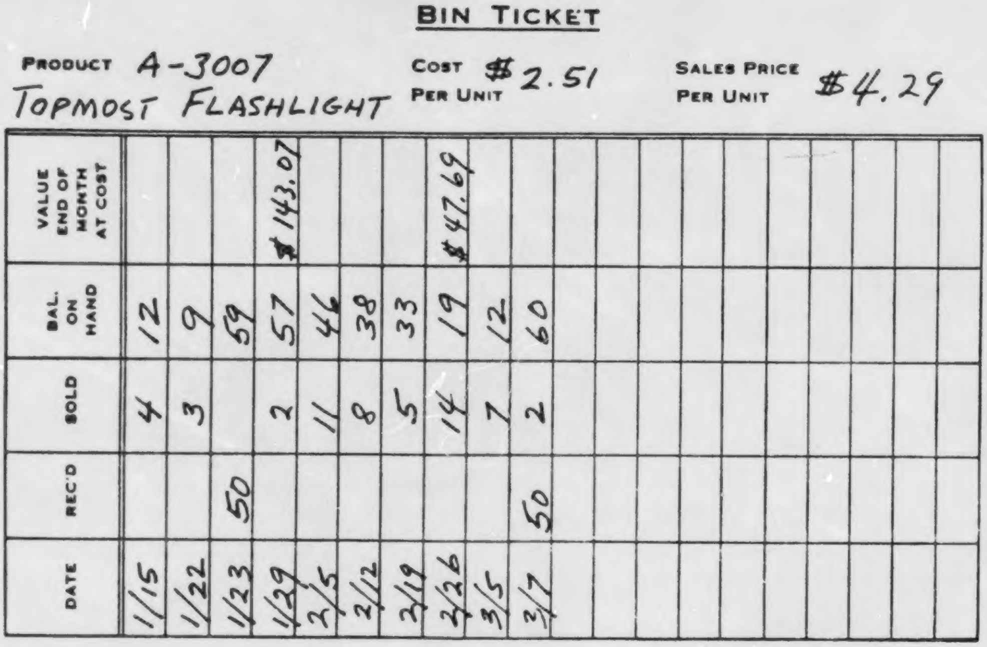
Step 4: Record the cost price per unit in pencil. If a new order is received at a higher price, the unit price is changed to reflect the *newest* cost.

Step 5: Either daily or weekly, show the sales of each item, and subtract that figure from the balance.

Step 6: When the balance reaches the minimum number, place an order for the amount shown as the maximum reorder.

Step 7: When the order is received, add it to the balance figure.

If you use and maintain a perpetual inventory system, recording and counting on a daily or weekly basis, these figures and records are acceptable for tax purposes. You do not have to conduct a year-end inventory of each item in stock unless you want to.



BIN TICKET

PRODUCT A-3007 TOPMOST FLASHLIGHT
COST PER UNIT $2.51
SALES PRICE PER UNIT $4.29

DATE	REC'D	SOLD	BAL. ON HAND	VALUE END OF MONTH AT COST
1/15		4	12	
1/22		3	9	
1/23	50		59	
1/29		2	57	$143.07
2/5		11	46	
2/12		8	38	
2/19		5	33	
2/26		14	19	$47.69
3/5		7	12	
3/7	50	2	60	

Fig. 32-2. Inventory stock card or bin ticket. (Courtesy Sun Oil)

Whatever your perpetual inventory sheet balances show as on hand on any given date is acceptable for government tax accounting.

Measuring Stock Turnover

Another reason for a perpetual inventory system is its ability to accurately measure stock turnover or stockturns. The secret of a successful business operation is its ability to make a profit, and *profits are made from stock turnover.* Profitability comes from selling items with a high turnover rate. The more turnover, the better the profit margin. Turnover keeps the retail price low and keeps the business competitive.

Turnover measures the number of times money invested in merchandise is returned and reinvested. For example, your initial investment in a tank of fuel is $5,000. You sell and refill that tank one hundred times during the year. Even if your profit margin is only $350, or 7 percent per tank, your original $5,000 investment will make you a profit of $35,000 during the year, or a return of 700 percent. Even though the markup percentage is low, the turnover rate more than makes up the difference so that your total profitability is extremely good.

On any single item of merchandise, the same principle is true. You may have a product that is attractive and is fairly priced. But if it is moving too slowly, regardless of other factors, it is costing you money.

Each item of merchandise represents money invested. It is either selling to make more money, selling only well enough to break even, or selling so slowly that you are losing money. A perpetual inventory system is designed to show you which items in stock are moving too slowly to keep. You get rid of them and replace them with items that will sell more profitably.

Stockturn is measured by a simple formula:

$$\text{Stockturn} = \frac{\text{net sales}}{\text{average inventory at retail}}$$

Assume that the net sales for spark plugs is $2,000, and the average inventory of spark plugs at the retail price is $650. To find turnover, divide net sales ($2,000) by average inventory at retail ($650). The result is 3. In other words, the spark plug inventory is turning at about three times a year.

Now, you want to know how much your dollar investment in spark plugs is doing. This is called *capital turnover.* Use the same figures, but use the average inventory at cost instead of the retail price. Let's assume that spark plugs take a 40 percent markup. That means the cost figure is 60 percent. Using the same figures as in stockturn, the result would be:

$$\frac{\$2{,}000 \text{ (net sales)}}{\$390 \text{ (\$650} \times 60\%)} = 5.1 \text{ capital turnover}$$

Your money invested in spark plugs has turned slightly more than five times during the year. So, you should keep stocking spark plugs, even though they are not making as much money as gasoline. At least the spark plugs are not costing you money by tying up expensive inventory investment dollars.

There is another factor to consider. Spark plugs are small in size, and a large on-hand supply takes up only a little space. On the other hand, 5-gallon gasoline cans take up a large amount of space, and the sales volume and resulting profit margin would probably be too small to justify stocking them. So, profits can also be measured by square footage of space occupied. An entire counter can be plotted and laid out with various products. A space is assigned to each, and the resulting profits can be measured by space. An average profit dollar per square foot is shown. If an item cannot at least meet the average in a reasonable length of time, it is discarded in favor of something else.

Questions

1. Why should gasolines and motor fuels be inventoried daily?
2. What is the recommended method of inventorying motor oils and oil filters?
3. Why should tires and batteries be inventoried daily?
4. How does the perpetual inventory system work?
5. Name four of the seven advantages of a perpetual inventory system that you think are the most important. Explain why you think these are the most important ones.
6. What is the importance of measuring stock turnover?
7. What does turnover measure?
8. Give the formulas for measuring *stockturn* and *capital turnover*.

Projects

1. Describe the inventory system and procedure used by your training station. Prepare a brief report on the procedure and the system, specifically answering these questions:
    a. How often is physical inventory taken?
    b. Are any items inventoried daily? weekly? monthly?
    c. Is a year-end inventory taken?
    d. Who is responsible for taking inventory?
    e. What kind of control system is used to prevent shortages?
2. Review the eight benefits of adequate inventory that are discussed in the text. Which three do you consider most important? Why do you consider these the most important ones? State your reasons in a brief report. If possible, relate your reasons to your training station.

33

Controlling Losses and Shortages

Objectives: After completing this assignment, you will be able to—

1. tell why most small businesses fail;
2. tell where losses come from in the operating budget;
3. tell how most losses and shortages can be prevented;
4. explain what a manager should look for when interviewing new applicants; and
5. give ten rules for a system of tight controls.

Every day numbers of small businesses go under. Most of them appeared to be prosperous, with plenty of customers. Yet they went broke—not for economic reasons—but because of poor management. One such typical case was Mr. C. He was an excellent mechanic and had built up a steady business over the years. He had customers waiting for a week or more to have him work on their cars. He bought a service station that had a good business, and Mr. C. never lacked for customers. The pumps, service bays, and repair shop were always busy.

Mr. C. learned one day from his accountant that he was broke. He could not understand why. He sold out at a loss. The new owner made it into a paying, thriving business in less than a year. What was the difference? One was a good mechanic who did good work and the other was a good manager. One is not synonymous with the other. It takes *good management* to make a business a financially sound, paying operation.

The foregoing illustration is repeated over and over. In its annual report on the status of business in America, Dun & Bradstreet gives the reasons why many go out of business. The leading cause is *poor management*. So many times the owner or manager is fooled into thinking that the business is sound because it looks good. There are plenty of customers, the employees are busy, and stock turnover is high. Appearances are deceiving. A business can be "on the rocks" financially and still look prosperous. The business is going broke with losses caused by poor bookkeeping, employee dishonesty, inadequate inventory methods, loose methods of handling cash and credit charges, and a number of other reasons.

Why Losses Happen

The Result of Shortages

Too many owners and managers of small businesses just assume that losses and shortages are part of doing business. They think that losses and shortages are part of everyday business expense and that nothing can be done about them.

Let's say you have a business that has a net profit in the markup to give you 10 percent, or 10 cents out of every dollar. That is high, but not impossible. If you have a loss or a shortage of $400, that amount can only come from one part of your operation budget—your net profit! To make up for that $400 loss, you have to sell an *additional $4,000*. If you don't, then your net profit for the period is going to be $400 less than what it should be. It is the same thing as making a mistake in subtraction in your checkbook. At the end of the month, your bank statement shows you have less than you thought you did. It doesn't make any difference what *your* balance shows. The real balance is the only thing that matters.

Another way to think about losses is what they do to you—the owner. What is your net profit percentage supposed to be? If it is 5 percent, then each dollar of loss or shrinkage is $1.05 out of your pocket. If the net profit is 7 percent, then each dollar loss is $1.07 out of your pocket. Shrinkage or loss is like a silent thief with a hand in your pocket who is robbing you constantly.

How Losses Happen

There are numerous ways that losses and shrinkage happen. Here are the more common ones:

- You fail to gauge your fuel tanks daily and after each delivery.
- You fail to take a daily inventory of high-cost items like tires, batteries, and tools.
- You fail to check your register and sales invoices daily.
- You fail to check your credit card invoices daily and keep them locked up.
- You fail to use job tickets with numbers on every service job performed.
- You fail to check incoming merchandise and inspect for shortages or damage.
- You don't follow up on informa-

tion supplied by job applicants. You don't call their references or run a credit check on them. You take their word at face value because you are anxious to hire someone.

- You don't price-mark your merchandise, or you use a grease pencil or other easily altered form of marking.
- You are away from your place of business quite often and seldom come around on your off-duty times.
- You don't have any security system on your storeroom, and all doors have only single locks.
- You have no security system on tools and equipment in your service bays.
- All employees are allowed to operate the cash register.

It is true that you cannot prevent all losses, and the owner or manager cannot be every place all the time. However, even with a burglary, robbery, or shoplifting, many losses can be prevented. Most shortages and losses occur in small amounts, but over a period of a year or even several months the total is staggering. It is enough to wreck a normally healthy business. These shortages and losses happen because of negligence or poor management practices. To prevent them, you must have a good system of controls and well-trained employees.

Methods of Controlling Losses

Hire and Train Good Employees

The first and most important rule of running a good business is to have the right kind of employees. Employees will either make or break your business. The first question a business owner or manager asks is this: "Why would anyone want to work for me?" What attracts good employees to a place of business? What can you offer? What are people looking for in a place of employment? These guidelines should help you answer these questions.

1. People want to work for a winner. Is your business successful, or does it look successful? Do you have plenty of customers and traffic to keep your employees busy? Your place of business should be clean and attractive, a place where people can work with pride.

2. People want to work where there is opportunity for advancement. Do you promote your employees? Do you have incentive plans? Do you reward good work? Are you fair in your promotion policies?

3. People expect to be paid a fair and decent wage in accordance with the prevailing standard of living. No one expects to make a fortune, but employees do expect a fair wage for the work they do. Underpaid or poorly paid employees usually find ways to make additional money. They will probably begin by doing it at your expense.

4. People expect to be trained to do their job. Adequate training pays many dividends. A trained employee is happier and better motivated. There is less likelihood of mishandling of money, invoices, and records when employees are trained and know what to do and when to do it.

5. People want to work where there is organization. No one enjoys working where there are too many or too few bosses. Nearly all employees want to work within a well-run structure where everyone knows his or her job. People want to know they can be trusted and given responsibility. Most will abide by the rules when the rules are known. And the rules must be consistent and consistently enforced. Otherwise, the organization, morale, and spirit of the workers are diminished.

Figure 33-1

Select Employees Carefully

You may be desperate for help, but it is a mistake to hire someone just because you need them. It is poor judgment to hire today with the idea that "if he or she works out, I'll check the references later." By the time you check, it may be too late.

Good managers have some basic qualifications for each job that they expect the applicant to have. This means having at least an idea of a job

EMPLOYMENT APPLICATION

Figure 33-2

description and the duties, responsibilities, and skills you expect. Check the application carefully. Look for inconsistent dates, or gaps in employment. A missing employer may be your cue that the person was fired for dishonesty, absenteeism, or perhaps a drinking or drug problem. All places of employment should check out. Call each one. Ask the person if he or she would rehire the applicant if given another chance. If not, why wouldn't they rehire? Make sure that all telephone numbers and names given are for legitimate employers.

Take time with the interview. After all, a few extra minutes spent in the interview may save you many dollars. Don't make hasty decisions or jump to conclusions without giving the individual a fair chance. Make sure the applicant understands the nature of the job, the duties, the hours of work, and the rate of pay. If the applicant hesitates or answers vaguely, then probe deeper to see if the person really wants the job or is just taking it until something better comes along.

Have a System of Tight Controls

An employee should know from the first hour on the job that there are certain expectations and a system of controls. The employee should know that you have checks to keep up with what is going on. An essential part of any good business operation is a system of controls—on money and on merchandise.

1. *Establish a daily checkout.* You should have a record or documentation for every sale of merchandise and motor fuel and for every service performed. If not, then all transactions cannot be checked. Any weakness in your control system is an invitation for dishonesty. Without invoices or records, you cannot check out each day and know how to account for every sale or service. If your business operates on long hours, with two or more shifts of employees, then you should have records for each shift. A person must be in charge during each shift.

2. *Balance out each day.* If every transaction is recorded, then it is easy to add up all the tickets, sales slips, register receipts, and invoices. The total amount of sales should be equal to the amount of cash and credit invoices taken in during the same period. If you begin with a change fund, then the same amount is taken out, and the remainder is cash sales for the day. Differences between on-hand and sales that amount to very much should receive your immediate attention. Try to trace the missing cash or invoice to the person responsible. Take immediate steps to correct the situation, and find a better method of control. Once your employees know that you are on top of the situation each day, the temptation for theft is reduced.

3. *Take inventory of expensive items daily.* Have a checkout system from the reserve stock. Use a numbered job ticket and invoice system so you can more easily trace lost or missing records. Record stock numbers of items so you can account for who sold what and for what amount. Gauge your fuel tanks daily so you will know exactly how much you sold and what amount of cash or credit was taken in for those sales.

4. *Safeguard your cash.* You must insist on every penny of cash sales being registered immediately. Check the change drawer often, and remove large bills and stacks of bills. A change fund of about $20 is adequate. Discourage acceptance of personal checks unless the maker is well known. Enforce rules on cashing personal and payroll checks. Make a bank deposit at least once each day. Never leave cash on the premises, even if you think you have a safe hiding place. Leave the empty register drawer open when the store is closed so a burglar will not ruin the register trying to open it.

5. *Keep tight security on credit card invoices.* Dishonest people always think up new ways to cheat, and credit card invoices are no exception. Here are some ways you can eliminate forgery and theft by credit card invoice:

- Check blank invoices when received, and make sure the invoice numbers are in sequence and that none are missing.

- Ration blank credit card invoices to employees on a day-to-day basis.
- Keep blank invoices locked up just as though they were cash.
- Require employees to initial each invoice they process.
- Place all signed and completed invoices in a drop box as soon as completed.
- Sort all completed invoices, and check for missing invoice numbers. Any ruined or damaged invoice should be marked "VOID" and placed in the drop box so the serial number will be in sequence.
- List all credit card invoices daily and transfer them to the daily sales ledger. In this manner, you can check back on duplicated cards.

Remember that credit card invoices are the same as cash. Treat them and secure them in the same manner.

6. *Keep up with labor charges.* All service work should have two records—a *work order* that authorizes the service work, and a *job ticket* or invoice that shows the work and charges. Do not allow any work done without an authorizing work order. In this manner, you know which employees are working and the amounts being charged for their labor. This prevents "free" labor for friends and relatives. It also helps you know if your service department is paying for itself or if it is costing you.

7. *Check your merchandise receipts.* Never assume that all merchandise and stocks delivered to you are correct. Always count and inspect the shipment. First, check the invoice against your purchase order to make sure that you are getting what you ordered. Second, check the shipment for correct stock numbers, brand names, sizes, and qualities specified. Third, check the shipment to make sure there are no shortages, substitutions, or damage. File damage and shortage claims immediately with the supplier or transportation company that made the delivery.

8. *Price-mark all merchandise.* Unmarked merchandise is fair game for both the dishonest customer and the careless employee. Most employees will undercharge rather than overcharge for unmarked goods. Use gummed or stick-on labels or indelible ink, but not a grease pencil or china marker. Any unmarked item should be checked before it is sold to the customer.

9. *Cut vending machines losses by constant maintenance and service.* All self-owned vending machines should have the money removed every day, or more often if needed. A dozen different keys will open any vending machine. All vending machine supplies should be treated just like other merchandise. They should be inventoried daily and kept under security until loaded in the machine.

10. *Be constantly alert.* Use your eyes and inspect your entire place of business frequently. Let employees know that you are alert and that you run a "tight ship." Employees respect a place that is well organized and run in a businesslike and professional manner. Inspect your inventory often. Look for places around the premises where break-ins might occur. For instance, look for ladders left outside that may be used to get up on the roof. Check all outside doors and entryways for loose doorknobs, hinges, or unlocked doors. Look for loose ventilators and transoms above doors. Make sure all windows are secure.

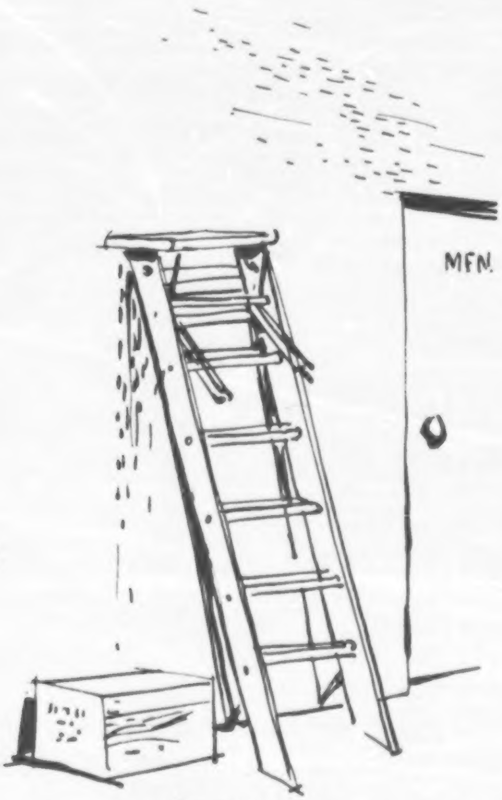


Figure 33-3

Questions

1. In a single sentence, tell why most small businesses fail.
2. From what part of the operating budget do losses come?
3. Assuming you had a net profit of 10 percent and a loss of $400, how much would you have to sell to make up for that loss?
4. In a single sentence, tell how most losses and shortages can be prevented.
5. What kind of business should you operate in order to attract good employees?
6. Name some things a manager should look for when interviewing applicants for employment.
7. What are ten basic rules for a system of tight controls to prevent losses and shortages?

Project

Prepare a list of all the rules and regulations your training station has for controls. List these as rules about handling cash, writing and recording sales, credit card invoices, merchandise, labor, supplies, and security of the physical building. If there are none, prepare a list that you think would be good for all employees where you work. Assume that you are the manager or owner and that you are preparing the rules for your own control and security.

Objectives: After completing this assignment, you will be able to—

1. explain why promotion of *new* business is a constant objective;
2. explain what is meant by setting objectives for promotion;
3. name eight forms of promotion; and
4. plan in detail a promotion campaign that has a predetermined objective.

34

Promoting a Business

Need for Promotion

There is one fact that you must learn about a business operation. A business cannot stand still and remain in business. Like any living organism, a business is either growing or dying! You cannot operate this year on exactly the same amount of business you did last year. The rate of inflation alone will do you in unless you promote new business.

We are a mobile society. Even though the rate is declining somewhat, about 20 percent of the population moves from one region to another each year. In other words, one out of every five families moves each year. That means that, on the average, you will lose one out of every five regular customers that you have this year. You have to replace those lost customers with new ones.

You will also lose some customers to competitors, and you need to replace those. You must try to regain customers who were once regular but began taking their business elsewhere. Finally, you must try to persuade occasional customers to become regular ones.

You must increase your business activity to meet your planned goals and objectives. No one plans to stay still or remain "even." You always plan for growth in sales, profits, and expansion. It is the only way you can stay healthy and stay in business.

Attracting Customers

Finding new customers is one thing, but you must first hold on to what business you have. Before thinking about promotion and how you will do it, you should take a good look at your place of business. Is it attractive? Is it clean? Is it well stocked with the merchandise that your customers want? Are you in a good location? Do you offer the services that your customers want? Are your prices competitive? Do your employees represent you well and convey the image you want to the public? Are you open the hours when the most amount of business can be conducted? Is your service work dependable? Are your policies reasonable?

Assuming that your answer to all these questions is yes, then you are ready to find ways to promote your business. At one time, premium merchandising was an excellent promotion tool. In today's economy, however, premiums are being dropped as expensive, excessive, and not all that good in promoting new business. Premiums are the "freebies" or giveaway types of merchandise. They were used to prompt customers to buy. For example, water glasses, dishes, automobile accessories, travel aids, and trading stamps were popular items. They were given if the customer purchased a preset minimum. The idea was to build sales volume and goodwill at the same time. If a customer started a set of glasses or dishes, it was very likely they would return until at least a complete set was accumulated. By that time, you had had an opportunity to turn them into regular customers. The additional sales volume was supposed to be enough to offset the cost of the premiums.

Since nearly everyone was in the same premium business, the original idea of premiums grew into a burdensome expense. It did not build new business and sales volume as intended. Too many places were giving poor service and expecting the premiums to offset it. Today, premium merchandising is not totally dead, but in the interests of building a strong business, you should consider other types of promotion.

Finding New Customers

To find new customers, you must know your potential market and market area. You begin by *defining your market area.* A city map will help. Locate your place of business, and then decide how far your customers

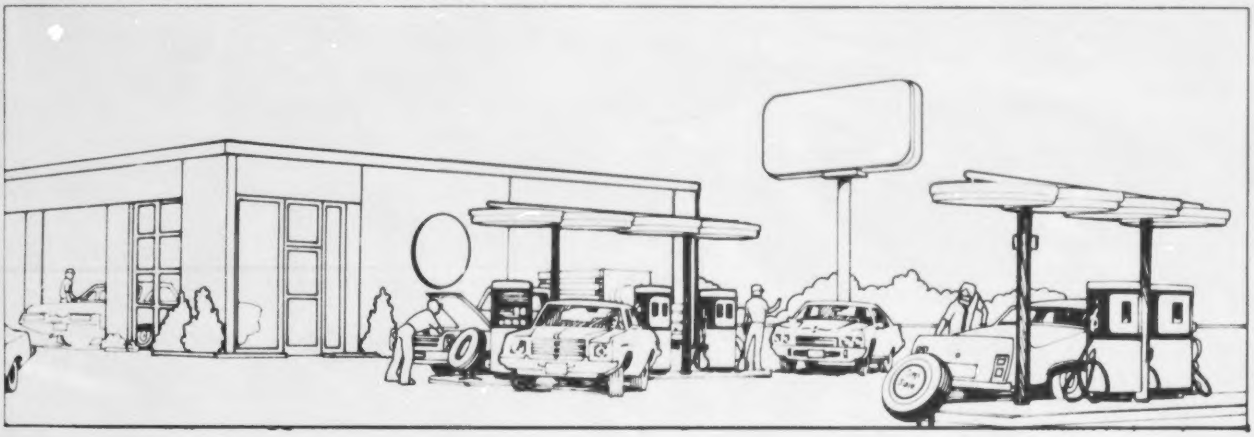


Fig. 34-1. Customers are attracted to clean, well-lighted, and active businesses. (Courtesy Mobil Oil Corp.)

will have to travel to reach you. What can you reasonably expect? If you have the right kind of promotion, you can attract customers from a great distance. But can you count on these to be permanent or regular customers? Probably not. For most small automotive products and service-type businesses, a distance of two to three miles or fifteen to twenty city blocks is about standard. Using a scale, you can put a pin at your location, and then draw a one-mile circle, a two-mile circle, and a three-mile circle. These are the reasonable limits of your market area. The second step is to find out approximately how many people and vehicles are within your market area. These can all be considered as potential customers. Information of this nature is available from the local chamber of commerce, city directories, and other marketing institutions. A local advertising agency can also be helpful.

The third step is to decide how best to contact these potential customers and bring them to your station or place of business. This is the job of promotion and the media.

Planning Promotion

Promotion is the various means or methods of mass communication. *Mass* communication is used because individual contact is too time-consuming and expensive. It is possible to use telephone contacts or a door-to-door campaign, but this will only work in some communities and types of neighborhoods.

Set the Budget

Before planning or mapping any kind of promotion strategy, you must first decide how much money will be spent. Promotion expense is a budget item just like any other expense. Normally, 2 to 4 percent of sales is a reasonable promotion figure. Five percent for most businesses is maximum. Retail service stations can usually expect a promotion budget of 1 percent of sales, or even less for a well-established business.

If you are a new business in a new location, then you may have to spend more than 5 percent to attract new customers and get your reasonable share of the market. This decision depends a great deal on your market area, the expense of reaching the market, and how much competition you have. Once you establish your dollar budget for promotion, then you know how much money you have to work with. You plan according to the dollars you have.

Set Objectives

Planning promotion is based on achieving or reaching some desired objectives. What are they? Do you want to find new customers? Do you want a larger share of the market? Do you want to meet or beat your competition? Do you want to hang on to your established customers? Do you want to increase your sales volume? Do you want to promote your service department, or one or more lines of merchandise, such as tires and batteries? Do you want to change or enhance your image? Once you establish your objectives or goals, then you are ready to decide on the best ways to accomplish them.

Forms of Promotion

For most retail establishments, promotion means advertising, display, and goodwill or public relations. However, promotion is not limited to these three.

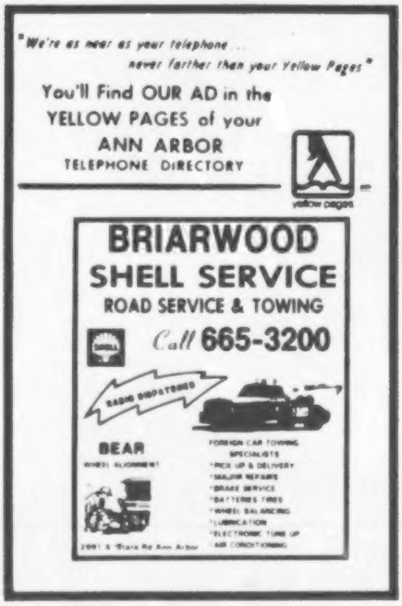
Advertising is a form of promotion or mass communication. It can be done in many ways, depending on the objectives and the budget. *Newspaper* advertising is effective for some things—for calling attention to merchandise or special prices. *Radio* and *television* spots are also effective, depending on the community, the market, and the promotional objectives. *Direct mail* is a very effective tool when properly done. *Circulars* delivered through the newspaper, through the mail, or distributed door to door are also effective.

For any kind of advertising to be effective, however, it must be properly planned and carried out. Advertising is a profession and should be treated in a professional manner. Unless you are skilled and trained in it, you will be better off letting a professional advertising agency help you. The agency is skilled in media, in costs, and in designing a campaign to help you achieve your objectives within the budget you have set.

Display is effective under certain conditions and for certain kinds of merchandise. Your windows and interior must be properly planned with promotion in mind. Most effective displays have a theme, a chosen group of products, and a purpose that is coordinated with the advertising. Banners, signs, posters, and other attention-getting devices should be well done, and not left to amateurs. A poorly painted poster, sign, or window gives a negative rather than a positive image and does more to discourage customers than attract them.

Personal solicitation is very effective, but also expensive and time-consuming. Personal solicitation can be useful in small communities and in some urban neighborhoods to build goodwill. It involves the owner or manager going from door to door and personally inviting people to trade with him or her. This impresses people, but only so many contacts can be made in a day's time.

Telephone solicitation is another useful method, but costly and time-consuming. It is probably less effective than handbill distribution for the costs involved. Either the owner or designated employees use a special directory to call potential customers within the market area. This service can be performed by paid solicitors.



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*WHEEL BALANCING
*LUBRICATION
*ELECTRONIC TUNE UP
*AIR CONDITIONING

2001 S State Rd Ann Arbor

Fig. 34-2. The telephone directory is a good place to advertise your business.

Handbills or **circulars** are single sheets of paper printed on one side and delivered door to door, by mail, or by newspaper insertion. This low-cost method of distribution is sometimes very effective.

Publicity can take several forms. It can be some sort of free service offered by the local newspaper that reports a new business or a relocated business. It can report a special trip or event won by the local business. It can report the owner being given an award at a state or national meeting, or being elected to office in a trade association. It can report the business's sponsorship of a community service or charitable organization. Anything of an unusual nature that involves community affairs, human interest, business news, or civic sponsorship can provide free publicity. This calls attention to the business itself and lets the public know of its involvement in civic and charitable organizations.

Most communities of medium to larger sizes have a **welcoming service** for new people moving into the community. This service is sponsored by local business organizations who give coupons or special deals to newcomers. Gifts are usually small and inexpensive, but are items that a newcomer would appreciate, such as a city map. An introductory coupon may offer a free lubrication job or oil change as a means of getting acquainted.

Credit can be a tool for increasing or creating new business activity. Many people will purchase merchandise if it can be charged or put on an extended payment basis. The interest rate charged for credit seems to be a very minor factor in the customer's decision to buy. Oil company credit cards are normally used to charge gasoline and motor oil purchases, plus the usual service and maintenance jobs. Some oil company cards have restrictions on other types of purchases: Many businesses accept the bank credit cards and encourage their use for large purchases of tires, batteries, brake jobs, shock absorbers, and similar repairs and installations.

Some dealers and retailers who do not want to pay for bank credit services have their own credit system. However, caution must be used in extending credit. It is costly, time-consuming, and in most cases does not pay for itself unless there is a large volume of sales. Most dealers do not have enough capital to finance their own credit department. Large purchases must still be sold to a bank and at a discount. This means the dealer gets none of the interest, and in fact must sacrifice a small percentage of the markup.

The Promotion Campaign

To illustrate how a promotion campaign is designed, built, and carried out, we will use an example. The business is Crown Tire and Auto Store, an independently owned retail distributor. The store specializes in tires, batteries, and the usual line of automobile accessories. It also has two pump islands and a four-bay service area for lubrication, oil changes, wheel alignment, brake service, and minor engine services that includes tune-ups and air-conditioning maintenance.

Crown is fairly new in the community. It is located on a busy six-lane divided traffic artery in a city of 100,000 population, but the trade area also includes four smaller communities that use this main traffic route.

The owner of Crown Tire and Auto Store wants to get a good share of the local market as well as some of the immediate trade area. The owner believes that the largest dollar sales potential and profit is in promoting the service work. Crown has a budget of 4 percent of sales for promotion. Since sales are expected to be $520,000, this gives a planned promotion budget of $20,800.

Since the main objective is to build sales for service and repair work, Crown wants the major portion of the budget directed toward this end. The owner turns the promotion effort over to a local advertising agency. In working out the plans, they decide that the mass communication job will be spent in newspaper and radio spots. The plan is to concentrate a major promotion effort for two months that emphasizes Crown's automobile service department. Newspaper ads will list the major services, and then use a discount coupon to encourage customers. This effort will be reinforced by fifteen-second radio spots on two local stations. The programming format of the two radio stations reaches more than half the potential market. These spots will run for two months during the promotion time.

To back up the newspaper and radio spots, the business itself will have outside banners and displays that call attention to the same promotion. Interior signs and banners coordinate the same effort. To bring in more customers, a tire promotion is planned and, later, a battery promotion. After the summer and early fall campaign, there will be a promotion to sell antifreeze and winterizing services. A last effort will be promotion of snow tires. Even though the campaign here is for specific products, purchases of $100 or more will receive a discount coupon for lubrications and repair services.

Any advertising effort or campaign needs constant evaluation. One way to evaluate this campaign's effectiveness is to count the number of coupons redeemed for services. These should be counted weekly and plotted on a chart. The weekly redemption rate will give some ideas as to what times and seasons are best for this kind of promotion. Another evaluation method is to compare the sales of the service department with those that were planned. Did the campaign increase sales? If so, which weeks showed the greatest gain? Did the campaign pay for itself in increased sales? How about the profit rate? Is it about the same, or more or less than that which was planned?

The owner can use the results of this first campaign effort to help guide those for the following months and years. The owner will find that certain kinds of promotion get good response while others do not. Some things that look good will not be productive. Other ideas that seemed futile will produce excellent results. Even if the promotion budget is cut the next year, the dollars spent may produce more sales than for the previous year. You learn about promotion only through experience.

Promotion will pay for itself when you follow these rules:

- Promotion must be budgeted.
- Promotion must be planned.
- Promotion must achieve some prestated goals or objectives.
- Promotion must be evaluated constantly.
- Promotion should be professionally designed and executed.

Questions

1. Why must *new* business be a constant objective of any enterprise?
2. Why is premium merchandising not as desirable for promotion as it once was?
3. What is the first step in planning a promotion?
4. What is meant by setting objectives for promotion?
5. Name eight forms of promotion.

Project

Reread the part of the text on "The Promotion Campaign." Use your own training station as your example. Plan a three-month promotion campaign that has any objective you wish. In preparing your plan, you should cover these points:

- Determine the specific objectives you want to achieve with the campaign.
- Set a budget of the amount you think should be spent.
- Determine the promotion methods you will use—newspaper, radio, television, handbills, telephone solicitation, etc.
- Describe the campaign, what you will promote, and how it will be done.
- Tell how you will evaluate the results.

This project should be made in the form of a report and attached to this assignment. Consult with your training sponsor if you desire, especially on costs and media, and review some prior campaigns that were successful.

35

Employee Motivation and Incentives

Objective: After completing this assignment, you will be able to design a program for your own training station that uses either an incentive plan, a commission plan, a commission pool, or a system of motivational devices.

In Assignment 34, you saw how promotional activities are used to stimulate growth and achieve certain objectives. Promotion is thought of in terms of building sales and enhancing the company's image. However, it does little good to promote products and the business unless you have some way of motivating employees. Any promotional campaign that is a success is one that has been discussed with employees and has involved them in the campaign.

Any plan that affects the business itself needs employee support. Otherwise, all your planning, efforts, and spending are going to do little good. Either your employees are motivated and want the business to achieve its goals, or else they are indifferent and will drive away your customers. How often does an employer plan a promotion, run ads in the newspaper, and have customers come in only to be met with indifference? How discouraging for the customer who gets motivated by the ad to find that employees haven't read the ad or don't know of a special price. What a waste of dollars and time and planning when employees are not in on the promotion.

Motivational Devices

Premium merchandising has taken a downturn. Few customers respond any more to free gifts and trading stamps. However, such is not the case with employees. Incentives and motivational devices are on the increase. In a recent survey reported by *Sales & Marketing Management* magazine in April 7, 1980, almost 70 percent of the business surveyed stated that they intended to use incentive merchandise for employees. Even with inflation, 60 percent said they would use *more*—not less—than the year before.

When asked why they used incentives and motivational premiums with employees, the businesses gave these reasons:

1. Stimulate and increase sales.
2. Keep employee morale high.
3. Concentrate effort on special products and lines.
4. Increase the number of new customers.
5. Increase sales in selected marketing areas.
6. Promote new products.
7. Increase market penetration.

These are some of the comments from employers and managers:

- "In our case, sales increase when an awards program is in force."
- "Incentives help us promote profitable items."
- "During times of inflation, incentive programs are well received by the employees."
- "Incentives help us achieve our short-term goals."
- "We have tough competition. Motivation for extra effort is a must."
- "Incentives motivate employees."

Incentive Programs

What are incentives and incentive programs? *Incentives* are premiums in the form of awards, gifts, or extra pay that are given for extra effort. An incentive may be a trip to the Bahamas or Hawaii. It may be a set of golf clubs, a silver tea service, a pen and pencil set, or some extra cash in the pay envelope. Whatever the form, the result is the same—employees are motivated by premiums and gifts.

Recognition is a form of award and is necessary, but a tangible gift is usually a prize worth working toward. Almost any size of business can have an incentive program.

At the beginning of a promotion campaign, the owner or manager announces the incentive program. It will have first, second, and third prizes, which are announced. Or extra effort will be recognized with bonus points, and the employee can select a prize from a catalog and note the number of bonus points needed to win.

The program itself must be simple, easy to understand, and fairly administered. The time span should not be too long. If it is, employees will give up working toward a goal that seems too far away. Any incentive plan, regardless of the award, should be only for *extra* effort. It should be understood that an incentive program is over and above the employee's regular pay. It does not take from that effort. A plan should be aimed at a specific achievement goal. Always protect the customer's interest in that you don't ask employees to harass customers with all kinds of sales gimmicks and pressures.

To map out a fair program for all, here are some guidelines:

1. Set quotas for each individual

based on past performance and ability.

2. Set a different quota for each line of merchandise, depending on its difficulty in being sold.
3. Use at least two different factors in a quota—dollars and units.
4. Analyze your market before setting up your quotas.
5. Set realistic goals for your incentive program.
6. Have measurable objectives so you will know how well the program works.
7. Get maximum employee participation. Don't forget the nonselling employees.
8. Make rules that are easy to understand. Avoid complicated formulas.
9. Give out the rules before the program begins.
10. Report individual scores frequently so employees have an accurate accounting.
11. Always have more than one winner.
12. Evaluate the results after the program is over, and include the various participants' evaluations.

Commission Plans

Not all incentives have to be in the form of gifts, awards, and prizes for special campaigns. You can have an ongoing program of commissions, bonuses, or royalties that reward continuous effort.

The plan works this way. You make a list of the products and services for which you want to push sales. Establish a commission rate on each item, as in these examples:

Premium tire	$5.00
Deluxe battery	$3.00
Shock absorbers, per pair	$2.50
Oil, filter, and lube job	$2.00
Wheel alignment and 4-wheel balance	$1.75
Tune-up, 8 & 6 cylinder	$1.50
Tune-up, 4 cylinder	$1.00

The list can be much longer. Usually, a commission rate can be set on the total cost, markup cost, or net profit for each item. Whatever rate is used, the amount should be consistent for commissions paid. The higher the commission, the greater the sales effort. You set your highest commission rates for those products or services where you want the greatest sales effort.

Each day, sales invoices are tallied, and each salesperson is given credit for the bonus items that are paid as a commission. A simple method is to have a card on each salesperson that lists the day, the commission items sold, the invoice number, and the amount. Then commissions are paid regularly and included in the paycheck or pay envelope.

Commission Pools

An alternative to the commission plan is the commission pool. This can be used in smaller organizations where everyone profits equally from the total extra sales effort. A commission pool is based on one of these three—total sales, gross profit or markup, or net profit. For example, the pool is based on one-half cent of each dollar of sales, or 2 percent of gross profit. The motivation is that each employee knows that for every dollar sold, money is going into the commission pool, so everyone tries harder. At the end of the pay period, the total commission pool is divided equally among the employees. That is the simplest plan and one that everyone understands.

You could vary the same plan, but reward each employee from the pool on a percentage basis. In this plan, a commission pool has been established that three-fourths cent of each dollar sold will be set aside. However, each employee shares from the pool according to his or her productive sales effort. It is a form of equality where everyone tries harder, but the individual with the greatest effort gets a proportionately larger share. This plan is fairly simple, but it involves more accounting and record keeping. Another factor about this plan is that you must give each employee the same amount of time in which to sell, and see that all have an equal opportunity to sell to the same number of customers. In other words, it would not be fair if employees working the late shift got fewer customers than those on the day or early shift.

Assume that the plan for the pay period showed the following results:

Employee A sold $3,800.00 or 33% of total
Employee B sold $3,150.00 or 27% of total
Employee C sold $2,600.00 or 23% of total
Employee D sold $1,975.00 or 17% of total
Total sales: $11,525.00 × 3/4¢ = $86.44 commission pool

Employee A receives $28.53
Employee B receives $23.34
Employee C received $19.88
Employee D receives $14.69
Total commission pool: $86.44

Combination Plans

Another variation is to reward each person individually with his or her own earned commission, but let each person share equally from the commission pool. Again, you are rewarding individual sales effort, but the total collective sales effort is split equally among the group. Using the same example as before, assume that each salesperson is allowed a 1 percent commission on sales and that three-fourths cent of each dollar goes into the commission pool. Then the plan would work this way:

Employee	*Net Sales*	*Individual Commission*	*Commission Pool*	*Total Commission*
A	$3,800.00	$38.00	$21.61	$59.61
B	3,150.00	31.50	21.61	53.11
C	2,600.00	26.00	21.61	47.61
D	1,975.00	19.75	21.61	41.36
Total	$11,525.00	$115.25	$86.44	$201.69

For sales of $11,525, you have paid commissions of $201.69, or 1.75 percent of sales. This amount can be taken either from gross profit as an extra selling expense or from net profit if you are trying to remain highly competitive with retail prices. Either way, your increased sales will more than offset the extra expense because all other selling expenses remain the same regardless of sales effort. In other words, it costs the business so much to open the doors each day. Fixed expenses go on regardless of the amount of sales. If sales are increased by only 3.5 percent, you are still better off paying the 1.75 percent commissions. Your employees are happier, better motivated, and more willing to meet any sales challenge because they can see and count the rewards.

Other Forms of Motivation

Incentive programs and plans give tangible rewards for extra effort. They are popular with employees because they are attractive and result in benefits that can be counted or seen. However, not all motivation is in the form of gifts, trips, and additional pay. There are other forms that are equally successful and just as rewarding.

Job promotion is an exceptional form of motivation. Most employees want to do a good job and want responsibilities. While additional pay may be appreciated, a job title and promotion are also needed. People want recognition for their efforts, and a promotion is a tangible reward. In small organizations, it may be difficult to find that many promotions, but increased responsibility along with a small pay raise is still a great motivational tool.

Pay increases are another form of motivation. Even when the increase is a small one, the employee feels that he or she is recognized and being rewarded for effort. It is a tangible way of telling the employee that "you are doing a good job and it is appreciated." With periodic small increases, the employee is motivated to try even harder.

Praise, privately and publicly, is a great motivator. People want recognition, and it does not always have to be in the form of pay or gifts. Any employee is encouraged when the boss comes by and says, "You are doing a great job." It is even better to recognize an employee in front of his or her fellow employees. Another good motivator is to recognize the "Employee of the Week" or "Employee of the Month" with a poster and photograph. This allows customers to see who is being recognized, and it has an extra benefit. Customers appreciate an organization that publicly recognizes its outstanding employees. It is another public relations effort that pays dividends.

Competition among employees is a motivator. This can be done by teams or by pitting one department against another in a sales competition. Rewards for winning may be monetary, or the losing team may host the winners with a picnic, dinner, or some other form of entertainment.

Goal setting, with employees assisting, is a great motivator. In fact, no growth effort will succeed unless employees are in on the planning. It becomes the *employees' plan* rather than management's plan. Employees will strive harder to achieve their own goals if they help set them. In fact, most employees will set higher goals for themselves than management will.

Proper correction can be a motivation tool. Correction should only be done *in private*. Ridicule and sarcasm never accomplish any purpose other than creating resentment. When an employee makes a mistake, the manager or owner should say something like this: "You have done a good job since you have been here, and I appreciate your hard work. I probably did not show you the proper way to read our code on the price tags. Let me show you how it is read and how to record it on the inventory form."

This is more effective than telling the employee: "I told you how I wanted that inventory information. Now, I'm going to tell you one more time, and get it right this time. I don't have time to do this every week."

When correcting the employee—in most situations—do it in such a way that the employee is allowed to "save face." When the employer is willing to take part of the blame, the employee will strive harder not to let the boss down again. The employee is motivated to listen and get the information correctly.

How to Present a Plan

Let's assume that you want to present some plan to your employees. How do you go about it? What is the best time and best place? Ideally, a plan or planning session may best be presented away from the place of business. If possible, invite your employees to a restaurant or other place with a quiet, relaxed atmosphere.

Let's say that you want to present an incentive plan or commission plan. Explain exactly what your plan is in overall, general terms first. State your goal or objective. Then, step by step, present your plan. Use visual aids, such as a chalkboard, poster, or large newsprint pad.

Invite questions. Make sure everyone understands your plan. Ask individuals for their response. Keep your employee's enthusiasm and motivation alive. If you are uncertain how the plan is being accepted, ask for responses. Encourage participation.

Follow up the meeting with your plan in writing, and give a copy to each employee to take home. At work, have the plan posted where it will be seen and remembered. Make it the topic of conversation often during the coming weeks. Keep up the motivation among employees.

Another method is to let your employees help you plan and set goals. For example, let's assume that a new company is moving into your neighborhood, and you expect tough competition. You get your employees together and present the problem to them:

"Southern Auto Supply is building a new place over on Jackson Road. I know you've all seen it going up. Well, they will be opening in another month, and they are going to take a lot of business away. They could really hurt us. They are a big national chain, with really competitive prices. What I would like to do with you is develop a plan of how we are going to meet the challenge. We have some good customers, and we don't want to lose them. I would like each of you to help develop a plan of action that we can use to give better service to keep our customers.

"Let's begin with a brainstorming session. You tell me your ideas, and I'll write them down. Don't worry about whether it's a good idea or not—we'll decide that later."

You now have the beginning of the employees' plan of action. Some ideas will be good, and some will not be workable. The main thing is to get employees concerned enough to want to take constructive action. It becomes *their* problem rather than your problem. Letting employees share in the planning process is a great motivator.

Projects

(Using your training station as the example, complete one of these.)

1. Design an incentive plan for your selling and nonselling staff. Decide the goal to be accomplished. Decide what products will be in the plan. Decide the length of time of the promotion. Design the system of incentives and rewards and how winners will be determined. Tell how you would present the plan and administer it.

2. Design a commission plan for a group of products and services, and show the commission rate or amount for each item. Tell how long the plan will be in operation and how you would administer the plan so it will be honest, fair, and rewarding. How will you evaluate the plan to tell if it is accomplishing your intended goals?

3. Design a commission pool plan or combination plan, and tell how you would administer it. What would be the commission rate or pool rate? Where would the cost come from in the budget? How would you evaluate the plan?

4. Design a system of motivational devices that you would use at your training station. Explain how you would go about setting up the system and how you would administer it. Use at least three different motivators in your system.

Objectives: After completing this assignment, you will be able to—

1. define *management* as it relates to people, merchandise, and money;
2. explain the importance of having an organization chart and job descriptions for management purposes;
3. describe the manager's role as leader and counselor; and
4. explain the importance of managing cash as it relates to budgeting, cash flow, and investments.

36

Management and Administration

Management Defined

If you plan to own or manage a small business, you need to begin thinking about management and what managers do. No other job in a business is so important or has so much responsibility. As the owner or manager, you are ultimately responsible for everything that goes on or, more importantly, does not go on. You may blame an employee for breaking a rule, but you are the one responsible for the consequences. All that is good and all that is bad finally come to rest on your shoulders.

Not everyone can or should try to be a manager. Management and administration requires particular skills and talents that not everyone has. People are not born managers. You acquire the skills of management and learn them like any other job. Being a manager means hard work, long hours, tedious planning, and heavy responsibility. For the right kind of person, however, it is immensely satisfying.

Management is the art of getting things done through other people. You cannot be a manager without others working under you and your supervision. Management is a set of skills, some collected experiences, and much knowledge about the business. But it has another important requirement. Many people acquire the skills and knowledge of management, but lack the *will* to manage. You must *want* to manage other people and the business in order to be successful.

What do you manage? Basically, all management responsibilities fall into three categories: (1) people, (2) merchandise, and (3) money. Some are good at managing people, but not merchandise or money. Some are good at managing money and merchandise, but not people. You must be skilled in all three areas to run a small business.

Managing People

Managing the work of a business involves other employees. Managing is getting the work done through other people. In a small business, the manager may take on some of the tasks, like selling, inventorying, ordering, receiving, and so on. Generally, however, the manager reserves most of his or her time for managing and supervising the work of others. The manager who tries to do the entire job while the employees assist is going to "burn out" soon and the business will fail.

To manage the work load of the business requires organizational planning. It may be only a mental plan, but it must be a plan. Most businesses—even small ones—have a printed *organization chart.* Such a chart is nothing more than boxes with lines connecting them. The boxes contain the names of either job titles or actual persons. Most show job titles. The chart shows the lines of authority and the areas of responsibility. It designates which job titles are responsible for what work. It shows the flow of authority downward and the flow of communication and responsibility upward.

To go along with the organization chart should be a set of *job descriptions.* A job description is usually a one-page summary of the job title, duties, responsibilities, and major tasks expected to be performed. It specifies any particular skills—such as mechanical or clerical—the person needs and any special tools or equipment the person would be expected to operate. It may also list the salary range and note any special features such as wearing a uniform, working shifts, or working on weekends and holidays.

These job descriptions should fit the organization chart and show which persons are going to carry out the work assignments. In very small organizations, there are usually no subordinate managers or supervisors. If there is more than one shift, there may be a night manager or shift manager. In larger organizations, there are usually middle managers or subordinate managers to the general manager. These people supervise a department and report directly to the overall or general manager. For example, you may have a service manager to operate the service bays and repair facilities, a stock manager to look after the stock of merchandise and parts, and possibly an office or sales manager to look after the entire selling operation. There may also be night managers or shift managers who have overseeing responsibilities.

A manager is responsible for the following duties as they relate to people or the work force. A manager may designate some of these responsibilities to others, but in a very small organization, the manager must do them.

1. Recruits, interviews, and hires employees who fit the organizational structure and job descriptions.
2. Trains new employees, and conducts retraining of all staff members.
3. Supervises all employees in the performance of their daily tasks.
4. Motivates employees through incentives, rewards, and personal praise for their work. Motivates through promotions and pay increases.
5. Implements a system of promotion upward through the organization.
6. Assigns work responsibilities where unusual or needed tasks are required.
7. Gives responsibilities to subordinates, and follows up to see that they are carried out.
8. Delegates specific authority to subordinates.
9. Plans daily, weekly, and monthly goals and objectives. Plans promotions and sales efforts.
10. Approves schedules and minor changes in routine that are suggested by subordinates.

In addition, the management of people at work requires that the manager be a leader. Employees follow examples set by their supervisors and managers. If the leader appears indifferent, employees react the same way. If the manager appears sloppy in appearance and does not maintain the property, employes will do the same. If the manager is always sour, harsh, and negative, employees will act the same. On the other hand, the manager who is always smiling, optimistic, neat, enthusiastic, and friendly inspires the same kinds of attitudes and behavior in his or her employees.

A manager is a counselor. Employees require occasional correction and disciplinary action. A good manager knows how to correct and discipline so that the employee is inspired to do better. Sometimes, personal problems and bad habits keep a potentially good employee from being her or his best. The manager counsels and works personally with that person to help the employee achieve his or her highest potential.

Managing Merchandise

Assignments 32 and 33 covered the subject of merchandise controls. Controlling is a management skill and one of the more important ones. There is a close correlation between managing merchandise, people, and money. First, the largest single investment that most retailers have is the inventory of stock on hand. The next largest investment is in payroll or labor expense of employees. Both must be productive and pay for themselves if you are to stay in business.

Managing merchandise is the management of inventory or stock. It means having a planned stock, a good system of perpetual inventory, and knowing how to buy wisely. Buying too much or too little is costly and will eat away at some of the profits. Buying merchandise that does not sell will eat up the profits for an entire period. Buying high-priced merchandise that requires a markup to make the selling price above competition is another way of eating up profits. Letting goods stay on hand too long, or not having a system of promotion, is costly.

A good system of controls keeps up with on-hand stock. Every item represents so much cash. Good management converts that stock into cash as quickly as possible—the sooner the better. It is better to sell old stock at a loss or give it away than keep it on hand too long. It is taking up valuable space that could be given over to profitable merchandise.

Managing Money

Most people think of cash as the money of the organization. It is, to a large extent, but money also includes merchandise and time. Time is cash because employees are paid for their time on the job. Wasting time is like wasting money, or like throwing away good merchandise. However, the management of money is for the most part managing the cash or cash flow.

Cash is the money in the cash register and in the bank account. It is the lifeblood of the business. The manager's job is to have only enough cash on hand each day to take care of the day's business. You need some for a change fund to start the day. That is about $20 for each register drawer. If each sales employee has an individual register drawer, then each needs a change fund, which is banked at the close of the day's business. Normally, enough cash will be taken in each day to more than offset the cash disbursements. The remainder will be put into the bank account as cash reserve.

It is just as poor management policy to have too much cash on hand as it is to always be short and have to borrow. Managing the cash assets of a small business is almost as simple as managing one's personal bank account. For comparison, a household budget counts on so much income each month. This payroll income is put into the checking account. From it are drawn the checks to cover the many bills that come due—rent, food, clothing, auto expense, utility bills, taxes, and so on. You manage to buy only those things that you can safely pay for out of the income you have. Ideally, you don't spend all of the income, but manage to put some aside in savings to take care of unexpected expenses in the future, such as medical bills.

In the same manner, a business takes in cash each day, and this is the income. From it are paid all the expenses—rent, utilities, taxes, salaries, insurance, uniform rental, and so on. Some is left over and is put into savings to draw interest. That amount is saved for unexpected purchases, such as replacing equipment, hiring a new employee, or the opportunity to make a good buy on merchandise. However, it is important to remember that *cash is not the same as profit.* Cash operates the business on a day-to-day basis. Profit is the return for good management. It is what the business earns for the owner.

As so often happens, an owner begins thinking of the profit as daily operating expense. He or she lumps the two together, and the business is soon in a critical financial situation because there is no reserve fund for emergencies or for growth.

Cash management involves planning the daily cash supply, controlling the cash flow, and investing the surplus cash into reserve funds. How does one manage cash? It is done by a carefully planned and executed budget. Again, think of the household budget. You manage by the use of a budget. You know your fixed expenses and your income. You control your cash flow to cover the necessary expenses and carefully control the excess to make sure you can handle emergencies and additional purchases. Some people manage to convert the surplus into securities that pay interest and help the money grow.

A budget looks like the one shown in figure 36-1. This is a typical operating budget that is planned for a period—a month, a quarter, or a year. In this example, the income is sales and is the 100 percent figure. For each $100 of sales, the cost of inventory is $60.17, and the markup or gross profit is $39.83. Out of the gross profit is paid $17.81 in controllable expenses and $6.19 in fixed expenses. What is left over is a net profit—before taxes—of $15.83. However, the owner's salary is taken from that amount, so the real after-taxes net profit will probably be about $4 or $5.

Sales	**100.00**
Cost of Sales	**60.17**
Gross Profit	**39.83**
Controllable Expenses	
Outside Labor	**.26**
Operating Supplies	**1.61**
*** Gross Wages**	**11.44**
Repairs and Maintenance	**.36**
Advertising	**.85**
Car and Delivery	**.82**
Bad Debts	**.01**
Administrative and Legal	**.47**
Miscellaneous Expenses	**1.99**
Total Controllable Expenses	**17.81**
Fixed Expenses	
† Rent	**2.17**
Utilities	**1.18**
Insurance	**.80**
Taxes and Licenses	**.88**
Interest	**.14**
Depreciation	**1.02**
Total Fixed Expenses	**6.19**
Total Expenses	**24.00**
Net Profit	**15.83**

Fig. 36-1. Typical operating budget

Where did the manager get these figures, and how did the budget get planned that way? The figures come from past experience—from figures of actual business operation for the past two to three years. If the business is growing, then that growth is plotted into the next year's budget. If some major equipment is to be purchased, then that is figured into the budget as over and above the normal. If you were starting a new business, you would get these figures from your banker or a trade association to show what the average has been for other similar establishments.

Now, the task of managing that budget is simple—up to a point. It is easy to see that if you planned wages of 11.44 percent, that is about the figure you would try to keep in line. But suppose business is good—better than you figured—and your sales are up 15 percent over last year. You would need to hire additional help to take care of increased business. So, you increase your income by 15 percent, and that allows you to increase your proposed or budgeted wage expense. Even if your income increases, not all of your expenses do, so that allows your controllable items to be adjusted, and still leave an increase in net profit.

Suppose business is off, and your income is 20 percent less than you figured. Do you cut all expenses by the same amount all the way down the line? You can, but it may not be the best management decision. It is never good business to lay people off unless you have to. Your fixed expenses are the same whether sales or up or down, so they can't be cut. But advertising needs to be increased rather than decreased. You increase your promotion budget when sales are down. Too many managers fail to do this. Instead, some items are increased with the idea of creating new business or additional sales. Take that money out of net profit or cash reserve. Invest it to build the business. That is smart cash management.

The foregoing is oversimplified, but it shows what is involved in cash management. There are other factors, of course. Credit is a big factor. If you have accounts receivable that are long overdue, you need to collect those accounts to generate cash flow. If you have bought merchandise on extended terms, you may be wise to pay off the account and save on interest charges. If you have slow-moving inventory, reduce the prices, and start money or cash coming in to your business. In other words, it is better to reduce the gross profit than to tie up the entire amount waiting for an item to sell.

If you decide to reduce inventory, you are also deciding to reduce sales. You can only generate income from two sources—sales of merchandise and sales of service or labor. Reducing either one in volume is the same as reducing your income. Convert slow-moving items into faster-moving goods. Select items that produce profits. You may have items with reduced markup, but if they sell fast enough, they produce more profit over the long term than the slow-moving items. Profitability is made on turnover—not on markup.

Managing Investments

Surplus cash is invested for growth. It is smart management to put some money aside each period and let it earn interest. Some surplus is put into a commercial account as open savings that can be converted to cash immediately. This earns a modest rate of interest while it is not needed. Over and above that is an investment amount [illegible] future business growth. That money is invested in high-growth funds for maximum earnings. These are money market certificates, U.S. Treasury Notes and Bonds, U.S. Treasury Bills, certificates of deposit, and similar types of both long-term and short-term investment paper.

Inventories are usually purchased with borrowed money. A merchant borrows $10,000 on a three-month or six-month short-term note from the banker. This money is used to buy inventory. This is sound management because the cash coming back in during that three-month or six-month term is paying off the borrowed money at a moderate rate of interest. Recently, interest rates on borrowed money have become excessively high. Many merchants have reduced their inventory on hand. This practice is reducing net profit because there is not enough on-hand reserve to make the ordering process efficient.

Merchants today are having to find every possible way to reduce their operating budgets. While this kind of management is not as good as it should be, merchants have no choice in making the necessary decisions. It is taxing on management to have to strain at each new price increase and continually spiraling expenses. The little net profit that is made is being eaten up with inflation. But these are unusual times, and good managers find ways to keep their business solvent.

Questions

1. Explain what *management* is.
2. Explain the importance of organizational planning in management.
3. What is the importance of job descriptions in managing people?
4. Briefly explain the manager's role as leader and counselor.
5. What is meant by managing merchandise?
6. Define *cash* as it is used in a business operation.
7. Explain how a business operation is similar to a household budget in cash management.
8. What does cash management involve?
9. How is a budget planned?
10. How is surplus or reserve cash managed?

Project

Assume that your career goal is to become the owner or manager of a small business operation. From the information in this assignment, prepare a short paper that includes the following information:

- Your overall objective in managing a small business (what you would want to accomplish as a manager).
- Personal qualities and traits you now possess that give you management potential.
- Personal improvement you would undertake to prepare yourself for management—including education beyond high school, personality development, and knowledge of the business.
- Steps you would take—beginning now—to begin preparing yourself for small business management.

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Establishing and Operating Your Own Business

Objective: After completing this assignment, you should be able to evaluate your own ability and aptitude for owning and managing your own business.

Toward Entrepreneurship

So you want to become an *entrepreneur?* That's a hard word to pronounce and to spell. It is pronounced *ahn-tray-pre-noor.* It is a French word that means one who owns and manages his or her own business enterprise. One of the great things about living in a country like ours is that you are guaranteed the right and freedom to do this. You can make the decision on your own and try it any time you want to. This assignment will tell you what steps to take to become your own business owner—an entrepreneur!

Are You Ready?

Let's say you have worked for a few years in the petroleum marketing or automotive products and service business. You have gained a lot of knowledge and experience. You like this kind of business and this kind of work. You have saved some money. You want to make this your career. However, you are not happy working for someone else. You want to own your own place and make your own decisions. You want to take home profits rather than a fixed income. You have an urge to work for yourself and see what you can really do. These are good beginning points—and good attitudes. But are they enough? Are you really ready to own and manage your own place of business? Let's find out.

Can Business Ownership Offer You a Career?

The answer is *yes,* provided you are the right person for it. First, owning your own business offers you the freedom to make your own decisions. Second, it offers you the chance to make a profit and decide what to do with it. Third, it offers you an opportunity to be your own boss. Fourth, it offers you a challenge to succeed and to build your business into something bigger and better.

First, *you can make your own decisions.* Under our system of government and our economic free enterprise system, you can make your decisions without interference from someone else. You don't have to consult a government agency or an official each time you want to make a change. That is what the word *free* means in free enterprise—freedom from interference and control over your business except as you want it. If you want to hire two extra people or three or fifteen—that is your decision. If you want to open another branch across town, it is your decision. If you want to put in a stock of groceries along with your petroleum products—it is your decision. If you want to hire family members as employees—that is your decision and theirs.

Second—and perhaps the greatest motivating factor—is *the chance to make a profit.* You must also remember that you can lose everything, including your savings and everything else you own. The freedom to operate your own business is not a guarantee that you will succeed. You are guaranteed only a free marketplace and a chance to try your hand at your own management ability. On the other hand, what if you never try? If you don't want to risk anything, you won't ever have the chance to make some big money. So, you must weigh assurances and security against risks to make good money. If you like the idea of a regular paycheck, retirement benefits, insurance and paid vacations, and a 40-hour workweek, then you may not like giving these up for no guarantees and no security, long workweeks, and perhaps a missed vacation or two.

Third, *you can be your own boss*—no more taking orders and directions from someone else. You are the boss, and what you say goes. But are you willing to make all the decisions and take the consequences? Can you direct other people to work? Can you supervise others and get them to do the work? Can you manage people and time? Can you get the work load done through other people? Suppose your competitor begins cutting prices and expanding. Can you make the necessary decisions to meet that competition and stay in business? Yes, it is good to be your own boss, but you must also be willing to assume a great deal of responsibility.

Fourth, you have *the opportunity to succeed and grow.* That opportunity is available, but you have to be willing to make it come to life. Nothing will happen in a business without hard work, planning, and imagination. Can you do it? Are you willing to take the challenge? Is the marketplace ready for you and what you offer? Can you attract customers and hold onto them? Can you offer a better product and better service? Perhaps a better question is "do you have the creativeness and imagination to make your business succeed and grow?" However, just because you open your doors to the public does not mean the public will come in and buy from you. You have to make it happen!

The project for this assignment is a series of questions to ask yourself and to answer. If you can answer 75 percent of them yes, then you ought to consider that business ownership is a definite possibility for you. You have the *potential* for success.

Steps in Starting a Business

Every year, about 300,000 new business operations begin. It is easy to start a new business. However, six out of every ten, or 60 percent, of those new business ventures fail within the first five years of operation. Why? According to the best sources, the two major reasons for business failure are (1) lack of management skills and (2) lack of money (undercapitalization).

Actually, most of the reasons why a business fails can be lumped under "management—or lack of management." Even undercapitalization is a lack of good management or lack of planning. Too many people go into business with too little knowledge, experience, skills, or planning—even with a certain amount of ignorance—that is, too many foolishly believe that just because the doors are open, customers will flock in and buy. Mostly, though, prospective business owners do not do a proper and thorough job of planning.

Step 1: Planning the Business

Every business begins with an idea. A new product is needed, or a particular type of business, or a location seems ideal for a business. A lot of planning is needed to put an idea into operation. A *business plan* needs to be drawn up. It should describe in writing the exact kind of business, the services and products to be sold, the market to be served, the organization plan, and the beginnings of a working budget. Specifically, the business plan should answer or attempt to answer the following questions.

1. *What is the nature of the product or service?* Assume that it is a service station you want to operate. Will you be a franchised dealer or an independent? Will you sell a full line of automotive products or only limited lines? Will you have service bays? offer mechanical repairs? have a vending area? cater to trucking needs or only passenger vehicles? cater to recreational vehicles? Above all, your plan ought to state the need for your business.

2. *What market will my business serve?* You should have an idea of a location for your business. Is this location in the center of your potential market area? Who is your market? What is their income? their family size? their education? their social and cultural backgrounds? their ages? their needs for your products and/or services? Above all, how many competitors are in this market area, and how well are your competitors covering the market?

3. *What locations are available to me?* You may wish to locate in a particular area and find that zoning laws will not permit it. You may find an already established business to buy. You may find a building, but discover that it needs extensive remodeling to suit your needs. You may find a building you like, but not in the most desirable location.

4. *How much will it cost to start up operations and to finance the first year of business?* This question must be answered with a preliminary budget. The budget must specify the expected income or sales for that first year. The sales (or 100 percent) figure should be divided into two parts. The first part should be the expected cost of merchandise, and the second should be the markup or gross profit. In order to know gross profit, you must know your expenses. What are they? They should be itemized and estimated. These are the major expenses:

- Down payment, or purchase price, or deposit on lease of the business premises, including building, parking lot, or any necessary adjoining property.
- Fixture purchases, rental, remodeling costs on building.
- Purchase price or lease price of any needed equipment, including vehicles.
- Purchase price of first year's inventory or stock of goods.
- All utilities, including telephone and toll charges.
- Stationery and supplies.
- Taxes and licenses for one year.
- Professional services of lawyer, accountant, business consultants.
- Owner's salary and employee's wages, including all payroll expenses.
- Advertising and promotion expense.
- Insurance premiums.
- Necessary travel for owner and/or employees.
- Dues and subscriptions.

These expenses should be broken down into monthly totals for budgeting purposes. For planning purposes, you should have enough cash in the beginning to finance the total operation for three months. In addition, you should have a cash reserve for unexpected emergencies. This planning takes the form of an operating statement and shows:

- Predicted sales volume—by month if possible.
- Predicted cost of inventory or stock—by six-month period.
- Monthly operating expenses, including both fixed and variable or controllable expenses.
- Monthly net profit—even though you probably won't have any for the first year of operation.

Other budgetary forms needed are these:

- A cash flow projection that shows the actual cash surpluses or deficits for each period.
- A profit-and-loss statement for the first year's operation.
- A balance sheet that lists the business owner's assets minus liabilities (what is owed). The result is the *net worth* of the business.

Step 2: Choosing the Legal Form of Ownership

Before you consider any form of business ownership, you should have at least three professional business consultants—an attorney, a banker, and an accountant (fig. 37-1). Without

ADVISER	ASSISTANCE AVAILABLE	HOW TO FIND IT
ACCOUNTANT	Can set up a pattern of bookkeeping that is easy for the owner to follow daily and for the accountant to work with at audit or tax time. Helps set up systems for the control of cash and handling of funds, and can suggest simple equipment like cash registers, multiple copy sales checks and other forms.	Bankers and lawyers often know accountants who are willing to work with small businesses. Accountants are listed in the Yellow Pages. The entrepreneur should confer with several accountants and check their experience and references before deciding on one. Fees are often based on daily and monthly rates and vary with the complexity and extent of the service. Fees should be negotiated in advance.
ATTORNEY	Can help in choosing a form of business; in drawing up partnership and incorporating agreements; making sure papers are properly filed with city, county and state governments; interpreting contracts and leases; arbitrating disputes within the business and for the business against others; consulting when the business owner is unsure of legal rights and obligations.	Lawyers may be located through friends, other business owners, suppliers, consultants, trade associations or through listings in the Yellow Pages of the phone directory. In most counties, local bar association referral services can arrange for a business person in need of legal counsel to meet with a practicing attorney in the area. The initial half-hour consultation fee averages $15. The consultation implies no further obligation.
BANKER	Has financial knowledge: loans, separate checking accounts for the business, other funding or bank services—such as billing service and credit systems. Is familiar with community; may suggest individuals and other institutions that can be helpful.	A banker might be contacted where the business owner has a personal bank account or near the business location for convenience. It is often advisable to establish a continuing relationship, keeping the banker informed of the progress of the business.
INSURANCE AGENT OR BROKER	Will evaluate insurance needs and set up packages to cover specific types of businesses. May be either an independent (dealing with several insurance companies) or a direct writer (employed by and writing policies for one company).	The business operator should talk with several agents, compare the coverage and costs of the insurance they offer, and select the program best suited to the company's needs—comprehensively and economically. Agent requires complete data on business operations, must be continuously apprised of changes affecting insurance coverage. Agents and brokers are listed in the Yellow Pages.
MANAGEMENT & MARKETING CONSULTANT	If specializing in small business can help new business people determine and juggle the many facets of starting: product determination, advertising, inventory, security, filing, hiring, pricing—hidden details that a new entrepreneur may not think of. Has access to other sources of information and contacts with lawyers, accountants, advertising agencies.	Consultants are listed in the Yellow Pages and can be found by talking to friends, others in the business. The Small Business Administration sometimes has suggestions and has its own SCORE (Service Corps of Retired Executives) volunteers who counsel business owners and charge only their out-of-pocket expenses. Consultants generally charge on an hourly, weekly, or daily basis—or on a monthly "retainer."

Fig. 37-1. Types of professional business consultants. (Courtesy Bank of America NT&SA)

them, you are seriously risking your business venture. First, you need an attorney to help you set up the kind of ownership best for you. There are three basic kinds of ownership—sole proprietorship, partnership, and corporation. You need legal advice on which is best.

Generally, a *sole proprietorship* puts all of the assets in the hands of the owner. The owner assumes all the obligations and debts of the business, gets all the profits, and makes all the business decisions.

A *partnership* is two or more owners—each putting up a share of the financing. It can be an equal partnership, with each partner putting up 50 percent of the money and sharing all debts and profits on a 50-50 basis. It also means the business decisions must be shared equally by both partners. A limited partnership means one or more partners puts up a percentage of the financing, but hires one partner to run the business.

A *corporation* is an artificial or impersonal owner of a business. It exists as a separate entity and can only function at the direction of its owners or shareholders. Many small businesses incorporate for several reasons. A single owner can operate the business without involving his or her personal property and assets in the business. A closed corporation lets one owner or family own the business. A public corporation must put its shares on the open market for purchase. Stockholders are not held responsible for claims against the business other than the amount of stock owned. Corporations can only operate by state charter and it is fairly expensive to incorporate. However, there are definite advantages, so an attorney is needed to advise the owner.

Step 3: Obtaining Financing

The second professional advisor you need is a banker. Few individuals have enough cash on hand to begin a business. They must seek additional funds, and that usually means borrowing the money from a bank or other lending institution. A banker will give you advice and consult with you about your business and its financial needs. The planning and budget that you prepared in step 1 are necessary before going to see your banker.

Besides a list of your assets, the banker mainly wants to know something about your character and ability. Your character is extremely important. What kind of person are you? Do you pay your debts? Are you trustworthy? Do you have a police record, or have you ever been in serious trouble? Are you a responsible person in the community? Do you participate in charitable, community, and professional organizations? Your ability is connected with your previous experience and knowledge about a business. How much experience have you had? Have you ever managed before or had a position of management or supervision?

Generally, your character and ability must indicate that you are a good business risk. A bank will generally lend you up to 50 percent of your financial needs. You need a good credit rating and a demonstrated ability to operate a business.

Other sources for money are the Small Business Administration, private investors or lenders, and small business investment companies. For minorities, funds are more easily obtained from the Minority Enterprise Small Business Investment Companies, most of which are federally funded.

A third professional advisor you need once funding is obtained is an accountant. You may want the person to help you set up your records and record-keeping system, or you may want the person to do all of your accounting for you. You need a reliable, trusted accountant to guide you in your financial operations, expenses, and cash flow management.

Step 4: Selecting Your Location

If you are going to have a retail operation, location is of prime importance. You must be in a location where your customers can see you and reach you easily. You must provide adequate parking space. You must be on or near major traffic routes. A wholesaler has other considerations, such as warehouse and storage facilities, access to railroad or trucking facilities, and adequate space for large quantities of material handling and storage. A manufacturer would have yet other location needs, depending on machinery, equipment, raw materials, storage, shipping, and distribution facilities.

You will need a lawyer to help you determine lease agreements, franchising, contracting, and a host of other matters. A competent insurance agent is needed to help you decide the kinds and amounts of business insurance. Not only is the location important, but so are the building, parking areas, and improvements to the property. You are foolish to sign agreements or contracts without professional assistance or advice. Too many important matters need to be decided and agreed upon. You need to know who owns what, who is responsible for what, and mainly what you are responsible for. "Gentlemen's agreements" have no legal standing. All agreements and contracts should be in writing and handled legally.

Step 5: Obtaining Permits and Licenses and Paying Taxes

Again, your lawyer and accountant will help advise you on the permits, licenses, and tax forms you must obtain. You will also need to know local zoning regulations concerning your business operation. If you engage in any form of interstate (traffic between states) commerce, you are subject to federal regulations on your business. Intrastate (traffic within a state) commerce is subject to state licensing and regulations. State and local regulations govern many kinds of special licensing and inspections. Most licenses are granted for one or two years and can be renewed with inspection and approval by the state or local agency in charge. For example, any food processing, storage, or preparation requires inspection and licensing by the state and local health departments.

Special kinds of equipment are subject to zoning and other regulations. For example, many types of auto service equipment are listed as hazardous, and persons under 18 years

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of age may not operate them or be around that equipment. Equipment or machinery that is excessively noisy or toxic or creates an odor may be subject to zoning, health, or hazardous types of regulations.

You need licensing for taxation purposes. You may be subject to paying state sales taxes, employment taxes, and all federal and state income taxes. There may be local taxes, school taxes, and all types of municipal and utility district taxes. There are federally imposed taxes on income and social security payments, unemployment compensation, and excise taxes. The same is true for state sales and use taxes.

Step 6: Insuring Your Business

You need a competent insurance agent knowledgeable in commercial insurance to guide and advise you. These are some of the many kinds of insurance you may need to consider:

- Fire insurance
- Liability insurance
- Crime coverage
- Automobile insurance on company-owned vehicles
- Worker's compensation insurance (required in most states)
- Fidelity bonds to protect against employee embezzlement of funds
- Business interruption insurance
- Employee health and life insurance (part of fringe benefit program)
- Key person insurance to protect against loss of key personnel, or death of a partner

Forms and Records

The following forms are examples of the kinds of information you should be prepared to complete for financial review. Any financial institution or agency that you would consult and request a business loan from would require this information. They are verification of your personal integrity (honesty) and worth. Use these forms as models, and complete your own, filling in the necessary figures.

Personal Financial Statement

Figure 37-2 is a personal financial statement or a personal balance sheet. Its purpose is for you to list all of your assets and all of your present liabilities. What is left over is your personal net worth. If you are going to open your own business as a sole proprietorship, all of your assets are at stake. More than that, this is a statement to the bank or lending agency of your value in terms of tangible assets. It helps the lender make a decision on how much risk to place in you and your business ability.

Projected Budget for First Year's Operation

Figure 37-3 is a projected budget for your business. It is for planning purposes only. It will guide you and your banker in deciding how much money you need to borrow to finance your first year's operation. The column marked "Past Year" is to be filled in if you are buying an established business. If you are opening a new business with no previous sales or operating budget, then you would project each figure by the month.

Balance Sheet

Figure 37-4 is a balance sheet for your business operation at the end of one year and two years. It is similar to your own personal statement of net worth, except that you itemize the assets and liabilities of your business. For planning purposes, you will be able to project the financial strength of your business for the first two years of operation. Many lending institutions require a three-year summary, but the size of the business and size of loan will determine the number of years.

Project

Are You Ready to Become an Entrepreneur?

This is a self-test. It is designed to see if you are ready to own a business, or if you ought to consider it all all. On separate paper, write a *yes* or *no* to each statement. Thirty or more *yes* answers—if they are honest—mean that you have made good preparation for business ownership and ought to pursue it further. Fewer than thirty *yes* answers mean simply that you need to give more time, thought, and preparation to a business venture. It is a test of readiness and aptitude—nothing more.

These questions were compiled by the Bank of America National Trust & Savings Association. This bank has had many years of experience in counseling and working with small business owners. They encourage small business and make loans to those who show aptitude and promise. They have published many pamphlets and brochures on the subject of establishing and operating small businesses. This Center is indebted to Bank of America NT & SA for making this information available.

Personal Considerations

1. I like to make my own decisions and try my own ideas.
2. I enjoy being challenged and thrive on competition.
3. I have evaluated my personality. It lends itself favorably to my proposed business venture.
4. I really like people. I am friendly and outgoing and can relate to others.
5. I am honest and ethical in all of my business and financial dealings.
6. I have willpower and self-discipline. I always get things done on time and plan ahead.
7. I like to work. I don't mind putting in a 12- or 16-hour workday in my own business if it demands it.
8. I have the energy to do all the work involved, such as lifting, hauling, cleaning, walking, standing on my feet for long hours, smiling, driving, or whatever it takes to make my place of business clean and ready for customers.
9. I can shoulder the full responsibility for running a business and take care of all the little details without it getting me down.
10. I realize I can't be all things to all people at all times. I realize that this will be expected of me, but I can handle the strain.
11. I don't know everything about this business. There is much to learn and I like new ideas. I can take advice from those I trust.

PERSONAL FINANCIAL STATEMENT

BALANCE SHEET

______ ______, 197__

ASSETS Everything you own with cash value.

Cash Money you have on hand and in the bank $______

Savings Accounts $______

Stocks, Bonds, Other Securities $______

Accounts/Notes Receivable $______

Life Insurance Cash Value $______

Rebates/Refunds $______

Autos/Other Vehicles $______

Real Estate $______

Vested Pension Plan/Retirement Accounts $______

Other Assets Furnishings, appliances, jewelry, furs, cameras, tools, pets, trusts, etc. $______

TOTAL ASSETS $______

LIABILITIES What you owe; your debts.

Accounts Payable $______

Contracts Payable $______

Notes Payable $______

Taxes $______

Real Estate Loans $______

Other Liabilities Court-demanded payments, etc. $______

TOTAL LIABILITIES $______

TOTAL ASSETS $______

LESS TOTAL LIABILITIES $______

NET WORTH $______

Fig. 37-2. Personal financial statement. (Courtesy Bank of America NT&SA)

PROJECTED BUDGET

	Past Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
SALES														
COST OF SALES														
GROSS PROFIT														
CONTROLLABLE EXPENSES: **Salaries**														
Payroll Taxes														
Security														
Advertising														
Automobile														
Dues and Subscriptions														
Legal and Accounting														
Office Supplies														
Telephone														
Utilities														
Miscellaneous														
TOTAL CONTROLLABLE EXPENSES														
FIXED EXPENSES: **Depreciation**														
Insurance														
Rent														
Taxes and Licenses														
Loan Payments/Interest														
TOTAL FIXED EXPENSES														
TOTAL EXPENSES														
NET PROFIT (LOSS) (before taxes)														

Fig. 37-3. Projected budget for first year's operation. (Courtesy Bank of America NT&SA)

BALANCE SHEET

	YEAR I	YEAR II
CURRENT ASSETS		
Cash		
Accounts Receivable		
Inventory		
FIXED ASSETS		
Real Estate		
Fixtures and Equipment		
Vehicles		
OTHER ASSETS		
License		
Goodwill		
TOTAL ASSETS		
CURRENT LIABILITIES		
Notes Payable (due within 1 year)		
Accounts Payable		
Accrued Expenses		
Taxes Owed		
LONG-TERM LIABILITIES		
Notes Payable (due after 1 year)		
Other		
TOTAL LIABILITIES		
NET WORTH (Assets minus Liabilities)		
TOTAL LIABILITIES plus NET WORTH (Should equal Assets)		

Fig. 37-4. Balance sheet for two years. (Courtesy Bank of America NT&SA)

12. I am adaptable. I can change if the business requires it of me.
13. I have a lot of common sense. I can reason things out and am a reasonable person.

Financial Considerations

14. I have an aptitude for figures. I can analyze my own financial condition and that of my proposed business. However, I realize that I need the services of a professional accountant to help me prepare records and statements.
15. I have enough money to go into the business I want and can get more from other sources. I realize I need the competent advice and counsel of a banker or other financial consultant.
16. I realize that my own standard of living will be lowered for the first several months of the business operation. I also realize that I may lose all of my financial assets in this business venture.
17. I realize the money I have borrowed will be paid back out of profits. The profits must be over and above the debts and taxes I owe before I can take them for myself.
18. I realize the financial risk I am taking. Even if the business fails and I lose my own assets, I still owe the money I borrowed and must repay it.
19. I realize that I need to protect myself and my family with insurance. I have consulted an insurance agent and have discussed my personal needs as well as those of the business.

Marketing Considerations

20. I know my community needs and can support this business. There are enough customers in my market area with sufficient income to buy my products and services.
21. I have studied my competition—their strengths and weaknesses. I know I can offer better services and that my products will be competitive in price and quality.
22. I have studied all of the locations available to me. I have studied the market area and know the physical needs of my business.
23. I have given some thought to how to advertise and promote my business. I know what I will have to do to attract customers to my business.

Management Considerations

24. I know that most business failures are a result of poor management. I have had experience in this kind of business and know how to manage.
25. I know the duties and responsibilities of a good manager. I know how to work with other people and get them to work for me.
26. I am familiar with and know the necessity for keeping good records on cash, merchandise, and labor. I know that I must report sales, income, and expenses for tax purposes.
27. I know that the success or failure of my business will depend on my employees and how well they treat customers. I know that my employees must be trained and retrained to keep them at their best.
28. I know that I cannot be at the place of business all of the time. When I am away, there must be a trained person responsible for running the business.
29. To be a professional, I need to belong to a trade association and seek their assistance and advice on matters related to my business.
30. I can operate my place of business and stay within my planned budget.
31. I know my suppliers and will seek their help, advice, and assistance whenever possible.
32. I know how to forecast sales and expenses. I like to plan ahead.
33. I know how to price my goods and services. I know how to figure markups or gross profit so that expenses are covered and some is left over as net profit. I realize that my retail price must also be competitive, reasonable, and what the customer is willing to pay.
34. I know how to control inventory so that I will not have too much on hand or too little. I know that inventory is money and that slow-selling items are costing me too much. I also realize that my sales depend on my stock of goods and that I must have enough to meet customer demands.
35. I know how to spot potential weaknesses where shortages and theft may occur.
36. I know how to collect past-due accounts without losing good customers who may fall behind in payments.

Other Considerations

37. I realize that going into business for myself means that I will be giving up security and many other fringe benefits, but I think the risk is worth it.
38. I have studied franchising and know its advantages and disadvantages for my kind of operation.
39. I have consulted an attorney on the kind of ownership and know which is best for me and my business.
40. I have discussed all of these considerations with my family, and they are in agreement. They will lend moral support and help when it is needed.
41. I have discussed my business venture with several friends whose advice I value and trust. They think it is a good idea and have encouraged me.
42. I know that even with good preparation and ability my business may still fail. I know there is a 50-50 chance my business will fail within the first two years. The risk is still worth it to me. I sincerely believe I can succeed.